MARCH 1957

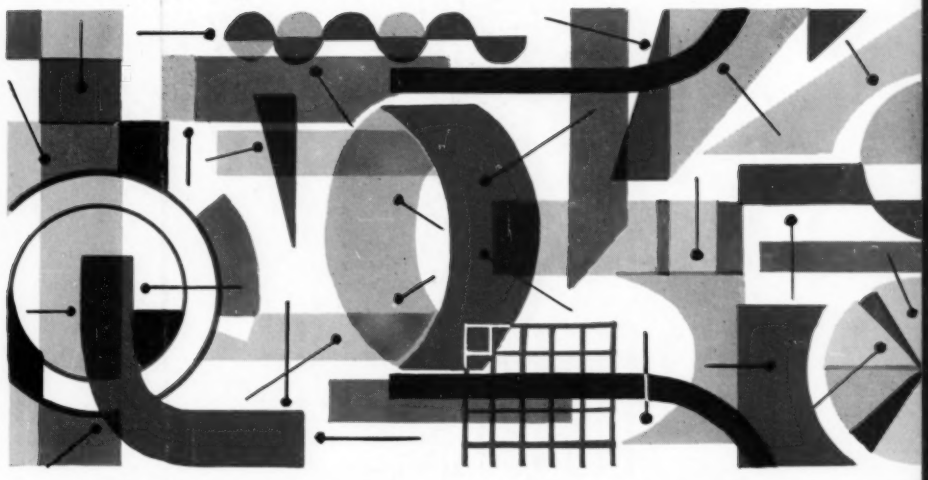
Research & Engineering

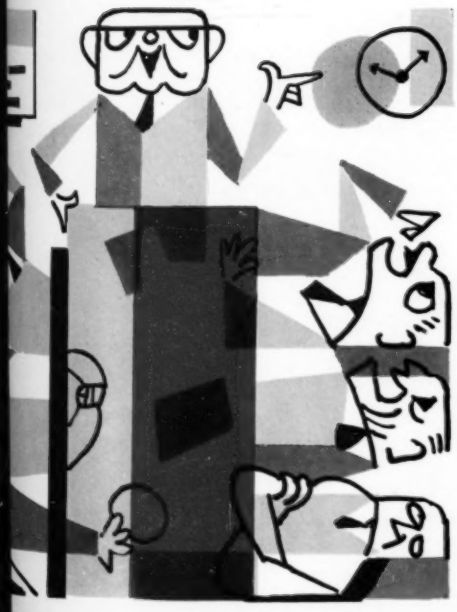
R/E

for MANAGERS of research design and development

453

the ubiquitous Seal





making the most of Committees

the Borazon story

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Amazing new RCA Storage Tubes

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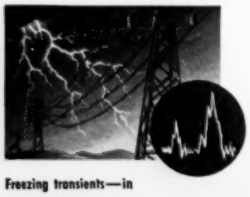

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Brilliant cockpit display of data—for improved aircraft navigation

Making time stand still—for medical research

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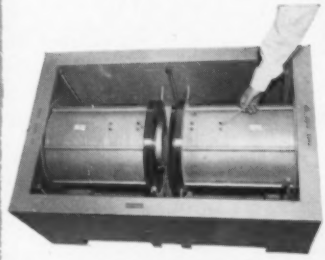

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Research & Engineering

for MANAGERS of research design and development

R/E

MARCH 1957
VOL. III, No. 3

Making the Most of Committees 10
Scott Nicholson

A committee is a way to compensate for the deficiencies of the committeemen. But unless properly used it can have an opposite effect. Here are some of the pitfalls and a guide to avoid them.

The Ubiquitous Seal 14
Arthur L. Kaufman and Melvin Mandell

Likening modern industrial seals to the kind of thing used for preserves is like calling a battleship a sophisticated canoe. R/E surveys a vast and variegated field.

The Borazon Story 22
Lawrence Sandek

Synthetic diamonds were announced two years ago. Now Borazon, two years behind and 2000° ahead, has arrived: another marker in a continuing research into crystal structures and ultra-high pressures and temperatures.

The Klugemacher's Dilemma 30
Anthony Blundi

A Swiftian view of brainstorming in research and development.

Technical Management: Growth Pangs of a Technical Manager 4
As an engineer rises through the managerial levels his new problems are not only technical but emotional and intellectual as well. Dr. Williamson offers counsel and invites more.

Face to Face: R/E Interviews Gott of A.M.F. 18
On the agenda with American Machine & Foundry's Executive V.P.: problems of diversification; evaluating new product ideas; long-range product development; transition engineering.

Letters	**8**	**Laboratory Equipment**	**38**
Materials	**28**	**Yardsticks**	**42**
Components	**35**	**Books**	**44**
R/D Contracts	**36**	**Advertising Index**	**47**

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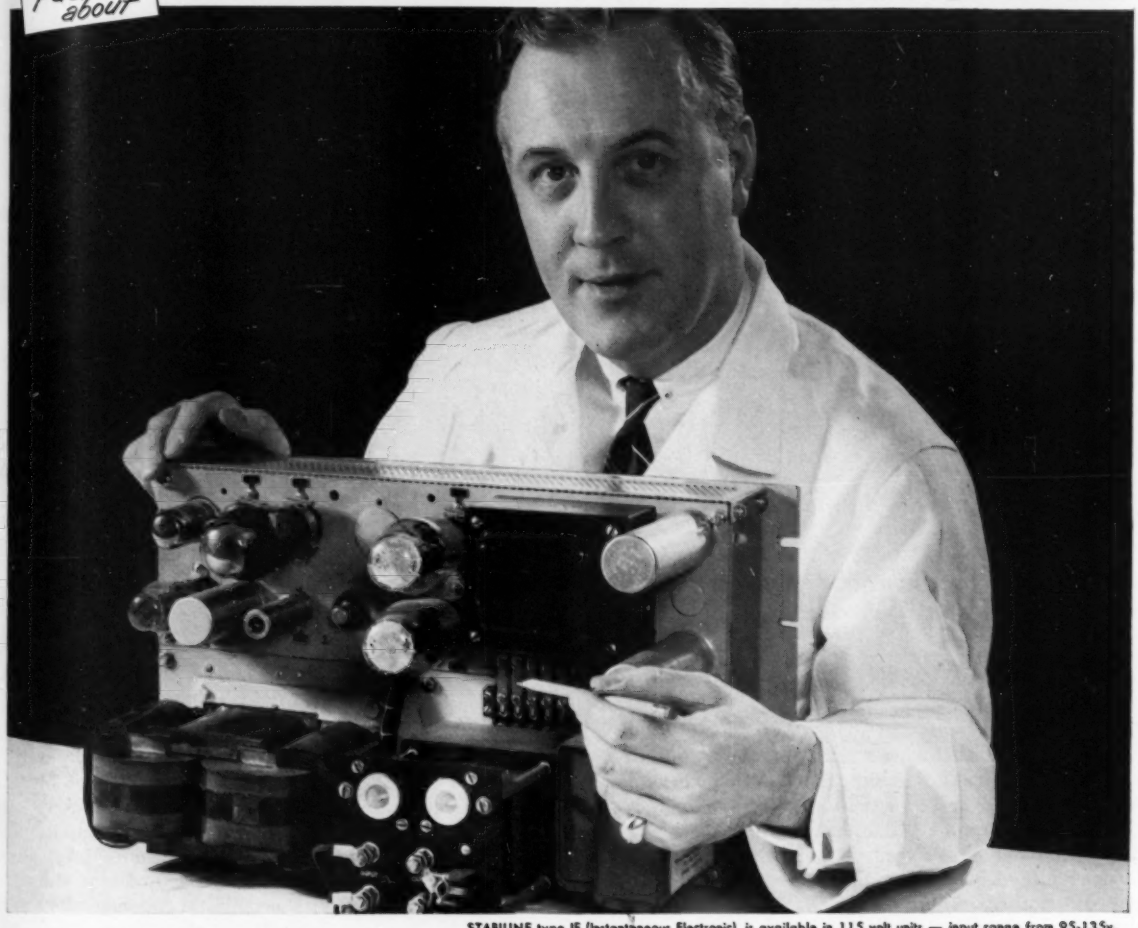

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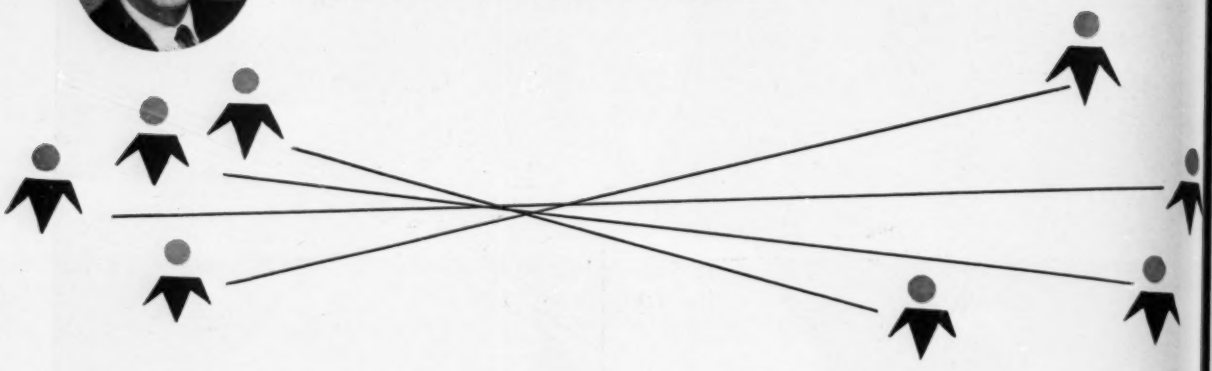
CIRCLE 3 ON PAGE 48 FOR MORE INFORMATION

TECHNICAL MANAGEMENT

MERRITT A. WILLIAMSON



GROWTH PANGS OF A TECHNICAL MANAGER

This month I would like to philosophize a bit on administration. There are many different definitions of administration. To try to standardize the use of these terms where research and engineering is concerned would be a difficult task. There used to be no doubt in my mind as to the distinctions between a manager, an administrator, and an executive. I conceived of the executive as one who does something or gets something done. A manager, to me, was an executive who manages, determines policy and selects personnel to accomplish tasks which he spells out and formulates. The administrator, to me, was one who makes it possible for others to function effectively in carrying out objectives and policies that are set by someone else. These were nice definitions except that they did not entirely conform to the literature which treats the management function.

First Stage

There are those in research organizations who make a fetish of the form and order, and there are others who dismiss the form and order as being of no consequence; they make a fetish entirely of the content. I believe that a research manager who evolves from the technical ranks goes through a stage of growth which embraces first of all a love of the content only. He starts off on a small project with a small team. He can make quite a few wide-sweeping changes in technical direction, and the word gets around without formal directives. The gang works as a unit and the person in charge may be very stimulating as a technical leader. The ability to inspire and the freedom to "free-wheel" are probably intimately related. The researcher sees the technical content of the project in very clear terms and selects those of his team who see it also. Little attention is given to anything but the technical content. This, in psychological parlance, is called a job-centered outlook.

From this point of view, any person or activity which diverges from the main technical objective is a thing to be abhorred—to be opposed at all costs. The job-centered group leader has little patience with the problems of other areas such as the marketing and financing of the developments resulting from his work. He wants to be left alone in freedom to pursue his job. If money is limited, then from his point of view management is stupid and will not listen to reason. Countless research managers have had to listen to this long tale of woe. It is a common attitude and one that has to be lived with. It is interesting that the intelligence of the group leader has nothing whatever to do with his attitudes. They are determined solely by his orientation. He is playing the role which he thinks is demanded of him. Because of his close working with scientists and engineers as individuals, he sees himself as their leader who must stand up for their point of view as opposed to management's budget control.

The Department Head

The next step upward would bring him to a position of department head where he has several project engineers reporting to him. He, in turn, may report to a division head. Now, as a department head, he has to see that technical work is carried out. At first, he has difficulty in getting away from the details of the projects. It takes a while for him to lose the urge to act as the project engineer on every project. At this stage he antagonizes the project engineers by infringing on their technical freedom. With one breath he will give a man responsibility for a job and in the next breath will tell him how to do it. It takes a person with more than average empathy to realize that these are precisely the supervisory tactics that he so vociferously resented when he was a project engineer. One thing he will find hard to learn, but which he really must master if he is to be successful in supervision, is that he must give the project engineers freedom, even to the point of letting them make mistakes. It takes a great deal of self control to see an engineer make a decision which will lead to an answer having no significance. Engineers must make decisions if they are to grow, and some of the decisions

(continued on page 6)

Formerly Research Director for Burroughs Corp., Dr. Williamson is now Dean of the School of Engineering and Architecture of Pennsylvania State University. He also acts as a consultant on problems in technical administration to industry.

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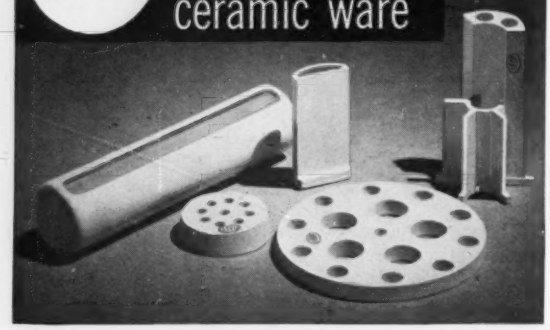

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TECHNICAL MANAGEMENT *(Cont. from p. 4)*

are bound to be wrong. The department head's function is to prevent *major* mistakes from occurring.

New Demands

Moving into the position of department head is difficult. He still considers himself "one of the boys", and yet the boys no longer regard him as one of them. He will initially behave toward superiors as he did as a project leader, and toward subordinates he will behave similarly.

It is at the level of department head that he gets an inkling of the value of some of the operations which he had previously regarded as bothersome. He becomes more concerned with money matters. He begins to realize that each project has financial limitations, and he becomes very much concerned with staying within the budget. The problem of resolving priorities is thrown into his lap and claims a great deal of his time. No longer does he have one technical goal to achieve; he now has several, and some of the projects require use of the same facilities at the same time. He must decide what comes first. He must delve deeper into the planning of the overall departmental work. He must continue to plan and yet not enter the planning of each project. This is the prerogative of the project engineer; and the supervisor's encroachment would be resented. It takes time for the department head to adjust to the demands of his project engineers, who want him to keep people out of their hair; and the demands of his boss who wants to know what is going on.

He discovers he can meet his supervisor's demand for reports only by instituting some sort of control, such as a fixed reporting procedure, meetings, etc. These help him because they give him the information which his boss requires; but they irritate his subordinates. He must arrive at a compromise. I've noticed that many men do not resolve these problems easily. Some never surmount the role of the project engineer. They try to keep fingers on the details of all work; and they continue to think about problems entirely from the technical point of view. As a result they become unhappy and frustrated because they don't know everything in technical detail. They cannot read all the reports. They get in trouble with their own bosses for neglecting whole areas of responsibility.

Some resolve the problem by refusing to face the problems of decisions and devoting all of their time to some technical area. Others try to meet the demands made on them and soon learn that they must play a different role. They gradually acquire appreciation for the service functions. Sooner or later it comes to them that there is a much bigger problem of coordination since the activities of departments must be brought in line with no overlapping, and there must be some way of seeing that good men are on jobs and that the work is carried out in accord with some sort of philosophy which is reflected in the system of reports and controls. When they have arrived at this realization and have abandoned their strictly parochial departmental attitude, they are ready for promotion. Anyone in a managerial position who can see and understand the problems of others and can take a position that someone else's work is more important than his own will not escape the notice of management. He is then ready for promotion.

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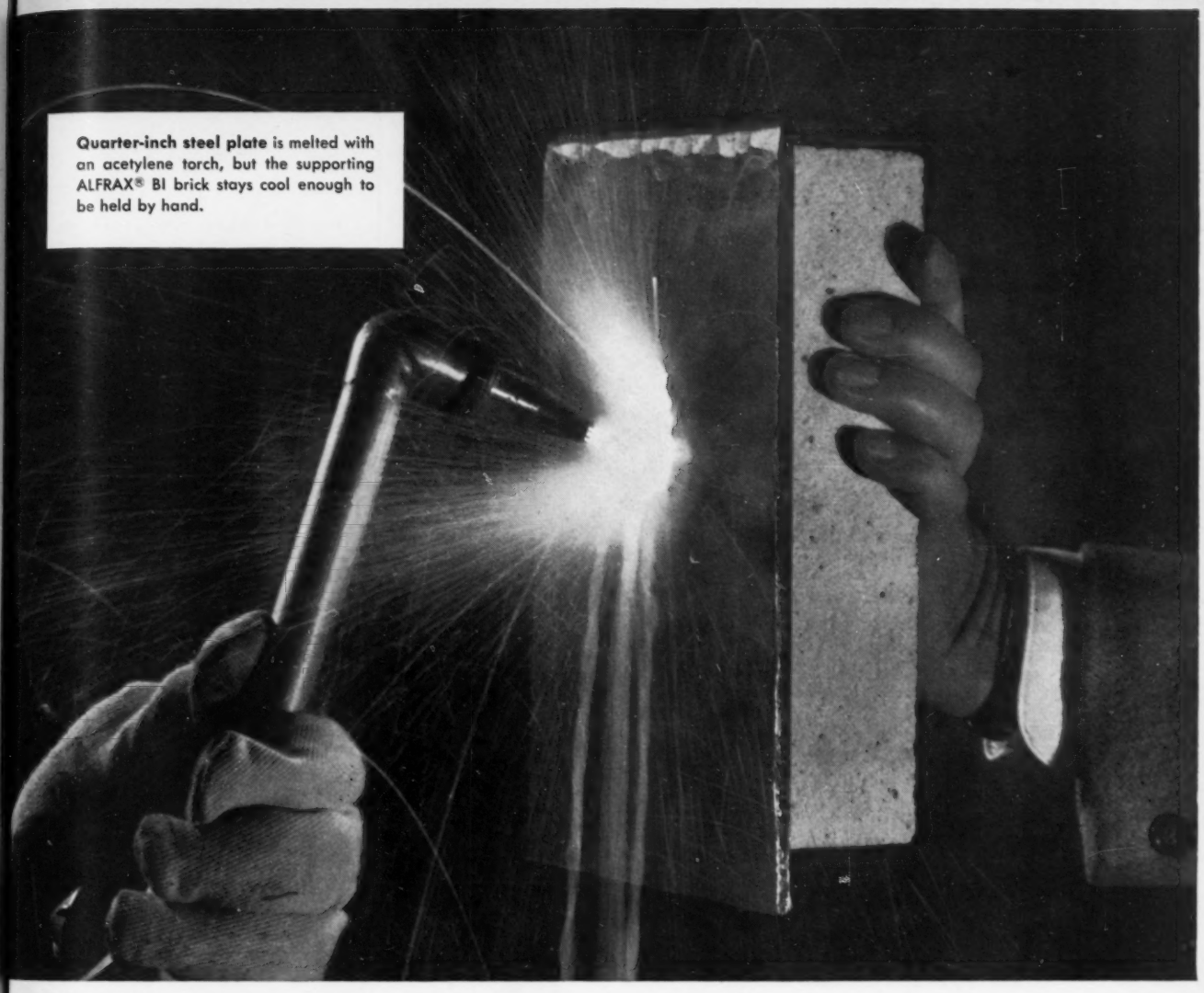

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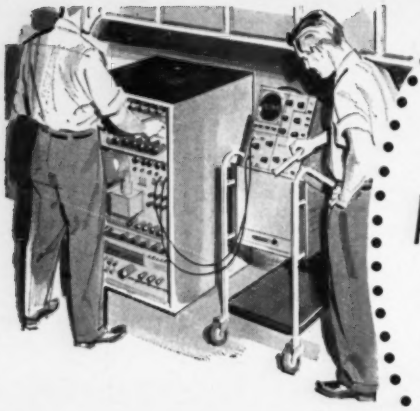

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Letters

Please send all letters to the editor to our editorial offices, 77 South St., Stamford, Conn.

Make 'Em All Human!

New York, N.Y.

I have read your January editorial on Human Engineering with great interest. I suppose it will not come as a shock to learn that there is still another splinter group that feels it has a stake in human engineering: industrial designers. Our magazine has had a few things to say on the designer's role in human engineering.

I feel it is unfortunate to assume that human engineering is an engineering job at all. It has been my observation that the job of translating machines into human terms is becoming more and more the job of the industrial designer. IBM's Ramac, Goodyear's GEDA, Lodge and Shipley's machine tools and the Kel-Ray atomic projector, to name a few, have been heavily influenced in their final form—arrangement of control mechanisms, over-all safety and function—not by engineers, but by designers.

The reason for this, I suspect, relates to your point about our need for "men who can understand not only a specialty but the entire system." The fact that the designer's training is not technical is perhaps the greatest advantage he can offer to industry. In his training he acquires a basic philosophical approach as well as a specific set of skills and facts, which make it possible for him to construct a humanly comprehensible whole out of many specialized parts. Perhaps the designer's growing importance in the creation of complex mechanical products suggests that what is needed is to make "human" engineers out of everyone practising in the engineering field.

JANE FISKE MATARACHI
EDITOR, INDUSTRIAL DESIGN

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Rutherford, N.J.

As an assistant professor of physics at Newark College of Engineering as well as an engineering consultant, I find your publication extremely useful. The entire January issue is excellent. I am particularly interested in Lawrence Sandek's "Did Your Education Educate You?". Would it be possible to obtain a copy of this issue for my files?

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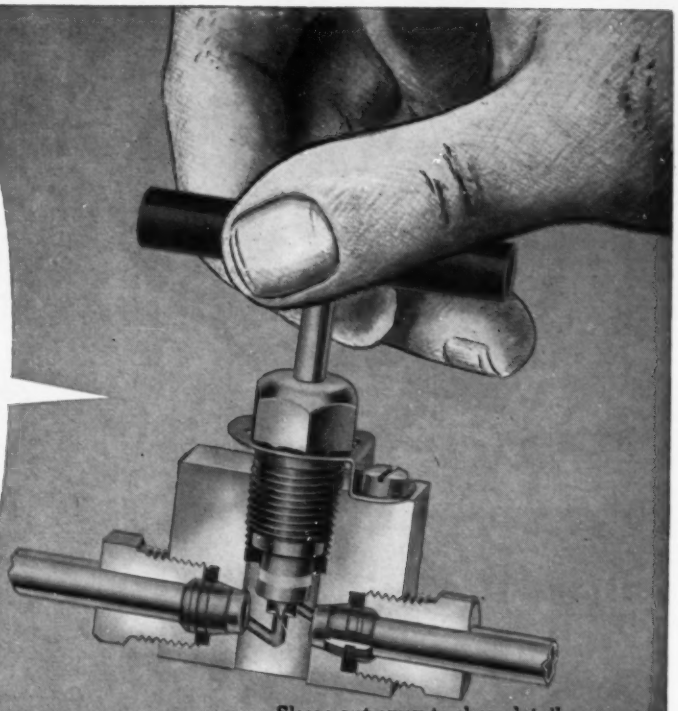
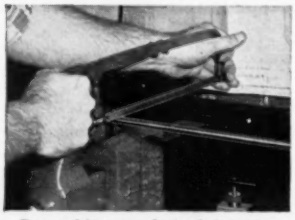


Sleeve cut away to show details

INSTALLED IN 3 STEPS



1. Cut tubing to desired length. Remove burrs.

2. Slip adapter nut and then sleeve onto the tubing.

3. Insert tubing into the valve as far as it will go. Tighten the nut.

Easy, fast tubing assemblies *to 10,000 p.s.i.* are now available with Autoclave Speedvalves and Fittings. The valves are quickly installed in 3 steps shown at left. No pipe threading . . . no tube reaming . . . no seal welding. Every joint is a union connection. The result: a gas-tight seal to 10,000 p.s.i. in less time, with fewer operations, at lower cost.

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CIRCLE 9 ON PAGE 48 FOR MORE INFORMATION

How many committee meetings have you left feeling that your time was wasted? Here are a few principles to help change your meetings into brisk and effective sessions.

It's comforting to share the blame

SCOTT NICHOLSON, associate editor

making the most of Committees

Judging from the amount of time spent in committee, attending meetings is becoming one of the most popular pastimes in Research and Development today. One company, for example, reported to RESEARCH & ENGINEERING that its top engineers spend as much as 20% of their time in committee. And while most labs are a little more conservative in their estimates, company after company reports that the amount of time spent in committees is increasing.

To many executives, these meetings are an unending source of frustration. The committee system, they charge, is cumbersome and inefficient. It pulls men off their duties and exasperates them with indecision. The recurring need for meetings, these managers charge, is a symptom of more serious organizational difficulties below the surface. By giving the appearance of agreement, committee meetings conceal the true nature of these difficulties. The participants leave each meeting as seething and frustrated as when they arrived. As one critic of the committee system complained, "To solve a problem you need to know the background and have a way of getting at the facts. In committee meetings, nobody has done the spade work required for action."

Meetings a Necessity

But despite these criticisms, the committee system rolls along as implacably as ever. The number of committees and the time spent in meetings is increasing rather than diminishing in most companies. "We're a committee company," an executive of the Texas Company straightforwardly admits, "And we don't see how we can avoid it."

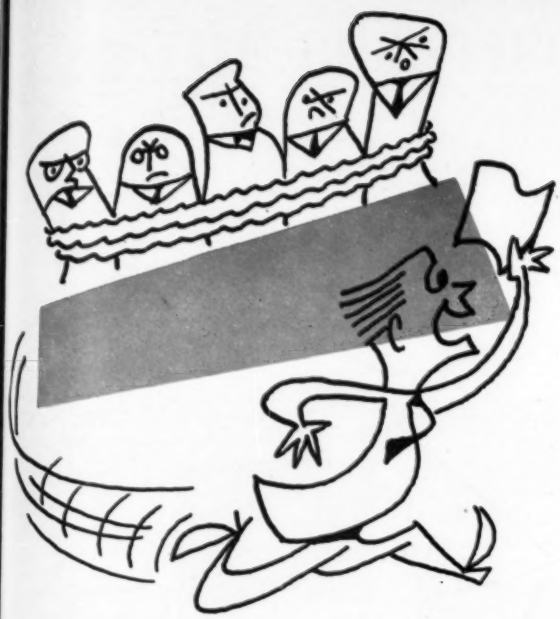
Most companies that use committee management extensively, justify their use in terms of plain necessity. The problems of running a research and development laboratory, they argue, have grown so complicated in the past fifteen years that no single individual can be expected to understand all the aspects of the problems he faces. He must go to other men for advice. This working together requires people to clear their plans and programs through others. The committee method offers a means of doing this, and thus avoids the misunderstandings that arise when managers fail to properly inform other people of their plans.

Most companies, however, while they acknowledge that committees are a necessity, believe they should be looked upon as exceptions from the regular operating routine. The committee system can be controlled, these critics say, by applying a few rules which successful managers have long used to master the committee problem. An examination of these rules shows that nothing very complicated is involved in making the most of committees—a few simple rules, but nothing that any manager who convenes committees can't learn.

1. Don't Use Committees to Pass the Buck

Every manager at one time or another faces the task of making an unpopular decision. He may, for example, be forced to refuse salary increases, deny promotions, veto projects, or rule against budget increases.

These are unpleasant tasks. It is natural that a boss should want to shift some of the responsibility. The committee system offers him a way of doing this. By making the decision a collective one, the group as a



An individual enjoys mobility

Group pressure is ever-present

whole becomes accountable; and the boss, if not relieved of his burden, at least shares it with others. For this we have committees that review promotions, establish salary levels, weigh budgets, evaluate research projects, judge new product ideas, and decide a host of ticklish questions.

Often, spreading the responsibility this way is enlightened management. Certainly, there are limits to how authoritarian a boss can afford to be. Yet one wonders whether in establishing committees a manager is using the group to escape the necessity of making up his own mind. In many cases, the questions over which the committee rules are questions which an individual could decide if he would take the difficult and laborious steps needed for a logical decision.

Before establishing a policy-making or evaluating group, therefore, the R/D boss should determine whether or not the committee is taking on responsibilities for decisions which are properly his and for which he must bear the ultimate responsibility.

2. Give the Job to One Person

Frequently, a committee is able to act positively on a matter because of one or two analytical individuals in the group who are able to define issues, clarify the alternative solutions, and lead the group to a sound course of action.

There are always likely to be one or two such men in every committee meeting. Why not, some critics ask,

(*continued on next page*)

There ought to be a time limit

An exchange of ideas is essential

throw the problem to these individuals and let them handle it themselves? By expanding their responsibilities, this would effect the needed organizational changes in the laboratory and would help solve many of the underlying difficulties in the department.

A single staff man with authority and know-how, can frequently do the work of several committees. He enjoys two advantages. He has the 1) mobility and 2) privacy needed for gathering accurate data.

3. Consider the Total Time Cost

From your point of view when you want to clear a proposal, convening a meeting saves time by bringing all of the interested parties together at once. You can gain everyone's agreement in one fell swoop. This way you avoid the many steps of interviewing each project leader separately.

But this rationale fails to take into account the time invested by the other managers. A much more accurate estimate, of course, would be to multiply the length of the meeting by the number of members present. Each time a meeting is called, busy managers are forced to leave pressing duties, abandon schedules demanding their attention and cancel appointments. The time loss far exceeds the original convener's saving.

4. Make Allowances for Group Censorship

An important advantage of the committee system is that meetings exercise a form of group censorship on stubborn managers. Most engineers want to be liked and respected by their associates. Because of this, they will usually modify their demands rather than make an unpleasant scene in front of fellow-managers. This group pressure toward conformity is very effective in smoothing the tenor of the talks and permitting the chairman to guide the meeting smoothly and politely.

However, the very fact of group censorship can be a serious drawback to effective action. It tends to cloak the real issues behind a facade of politeness. A manager will think twice before a mentioning the true cause of a problem in front of the culprit. Generally, engineers will withhold criticism of their associates and refrain from placing the blame where it sometimes belongs—on personalities. For example, in deciding why deadlines are not being met, committee members will touch on almost every answer except the one which is the crux of the problem—bad management in a particular department. Because managers don't like to air their grievances in public, committee protest has a way of becoming muffled.

The manager calling a meeting, therefore, should realize that he is not assured of an accurate picture. The most profitable meetings are those where the issues involve impersonal items, such as procedures and communications, etc.

5. Don't Rationalize Your Motive

A manager usually gives an acceptable explanation for a meeting. He wants to get "squared away" on policy or to get "everyone's viewpoint". Frequently these are only surface reasons. Managers do not hint—often

Assign the Follow-up to One Man

do not even realize—their real motive for calling meetings. Unrecognized motives may range from the harmless business of seeking praise to the more serious business of office politics.

Let's take praise. When an engineer has finished preparing a report, he naturally wants to show it around and learn other people's reactions. Social niceties, however, compel him to present the report "for your information" and say that he "invites criticism". Taken at his word, criticism is just what he gets. And this misunderstanding gets him mired in a lengthy and heated defense of his work.

6. Encourage Participation

One real advantage of the committee method is that it brings the background and experience of many people to bear on a problem, not just that of one person alone. For example, a typical R/D committee meeting of seven engineers will bring over a hundred and fifty years of experience to the meeting and seven widely differing points of view. Because it allows such amassing of numerous viewpoints and backgrounds, the committee avoids the single-answer deadlock that plagues so many decisions when one person depends upon his own limited range of ideas. Committees make it possible to pool the ingenuity and varied viewpoints of many members, and thus arrive at broader solutions.

To squeeze the full value from this aspect of meetings, the wise chairman encourages every member to put in his two cents. He can't afford to be a special pleader or and advocate for one side of an argument. He sees his main role as that of a guide, remaining outside of the discussion and steering it along profitable lines.

This approach brings two rewards. First, it makes the greatest use of the varied backgrounds of the members. And second, it enlists the full cooperation of the members in projects which they'll be helping to carry out. People

(Continued on page 34)

Tearsheets of this and other articles appearing in R/E are available free to our readers. You can request one tearsheet of each article in this, the Jan. and Feb., 1957, and all twelve 1956 issues from Editorial Offices. RESEARCH & ENGINEERING, 77 South St., Stamford, Conn. Complete copies are one dollar each in limited quantities.

THE PLENTIFUL RARE EARTHS

some facts about a clubby clan of elements that are rare in name only

a report by LINDSAY

We got to thinking the other day that perhaps a lot of industry folks are passing up a diamond-studded opportunity because they believe the rare earths are unavailable in commercial tonnages. Nothing could be farther from the truth. Rare earths are *not* rare! Commercial salts of the rare earths are available, right now, for prompt shipment in quantities from a gram to a carload.

That the rare earths are so plentiful is due, in large part, to Lindsay. During the last 50 years, Lindsay has developed the extraction and separation of rare earths to a high degree.

New equipment and processes are now in operation at Lindsay's West Chicago plant and are producing greater quantities of these versatile materials in higher purities than before.

FROM 57 THROUGH 71—Some chemists call rare earths Lanthanides, Lanthanons or the Lanthanum Series. Actually they are not earths, but trivalent metals, a rather amazing family of elements . . . atomic numbers 57 through 71. They are grouped together because they are always found together, with thorium and yttrium, in ores such as monazite, and all have closely related properties. While rare earths are technically metals, Lindsay produces them in chemical salt forms—individually or in combinations.

ATOMIC NUMBER	ELEMENT
39	Yttrium
57	Lanthanum
58	Cerium
59	Praseodymium
60	Neodymium
62	Samarium
63	Europium
64	Gadolinium
65	Terbium
66	Dysprosium
67	Holmium
68	Erbium
69	Thulium
70	Ytterbium
71	Lutetium
90	Thorium

SOME USES FOR RARE EARTHS

LANTHANUM—As lanthanum oxide in a high refractive optical glass, particularly for aerial cameras and other instruments.

CERIUM—Glass polishing. Scavenger in explosives production. Radiation protection glass for atomic reactors. Opacifier for porcelain. Oxidizing catalysts in organic preparations. Ultraviolet light absorber.

MIXED RARE EARTHS—Misch metal for lighter flints and alloy uses Motion sickness medication. Cores of arc carbon electrodes. Aluminum and magnesium alloys.

PRASEODYMIUM & NEODYMIUM—Dichroic colorants for ceramic glazes and glass. Used in better grade sun glasses. They do not lower light permeability and index of refraction when used as colorant or decolorizer. Ceramic capacitors.

The rare earths are becoming increasingly important in the production of steel and steel alloys. Small quantities added to the metal in the ladle result in a strong, fine-grained steel. Steel thus treated has great resistance to low temperature oxidation and corrosion. Stainless varieties have better hot and cold workability. Silicon and electrical grade steels have better electrical qualities.

Rare earths added to cast iron act as powerful deoxidizers and help remove sulfur from the molten metal. They are responsible for cast iron that is resistant to scaling at higher temperatures and to certain corrosive atmospheres. In malleable metals, they act as a carbide stabilizer.

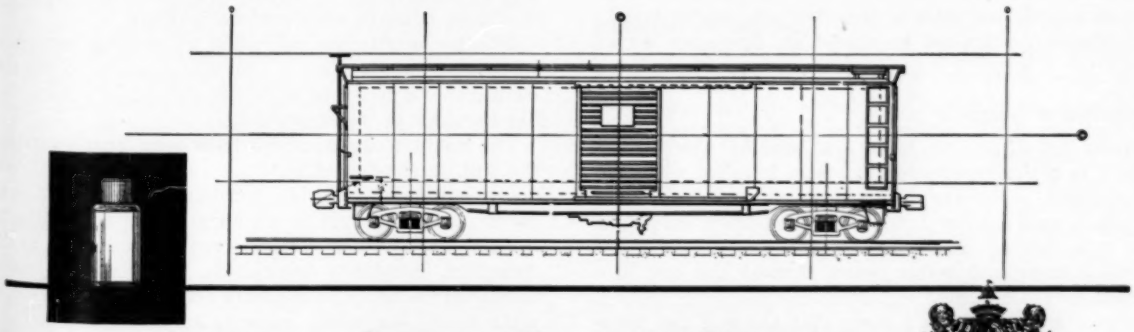
Magnesium-rare earth-zirconium alloys have excellent casting qualities and mechanical properties that make them ideal for important light-weight stressed components of aircraft engines.

Other rare earth compounds are used extensively for waterproofing, mildewproofing, weighting and dyeing of fabrics and compounding printing inks and phosphors.

LIKE AN ICEBERG—You might compare uses for the rare earths to an iceberg. What you see is only a small part of what lies undiscovered under the surface. In all probability, there is a real place for one or more of the rare earths in your operations. New uses—and profitable ones, too—are being discovered constantly. These versatile elements offer so much promise in so many different ways they merit your investigation.

To industries interested in the rare earths, we offer detailed technological data compiled over the years by our research staff. We will also furnish samples for experimentation.

And please remember . . . the rare earths are *plentiful*. Lindsay can supply you with quantities from a gram to a carload.



PLEASE ADDRESS INQUIRIES TO LINDSAY CHEMICAL COMPANY

274 ANN STREET • WEST CHICAGO, ILL.

Sealing is a common denominator among researchers and R/D engineers. Here's a comprehensive survey of this art turning into science.

The Ubiquitious SEAL

ARTHUR L. KAUFMAN and MELVIN MANDELL, editor

The electronic engineer worried about sealing a tiny germanium diode and the nuclear engineer concerned about the hermetic seal on a giant reactor core do not appear to have much in common, but both are looking for a seal that will last for years. The housewife with her pressure cooker may not be in the same league with the scientist attempting to achieve 10^{-9} mm Hg vacuum in a laboratory bell jar, but both want a seal that can be dismantled over and over again without leaking. Trying to keep a variety of liquids, vacuum or gases in or out of a container with wide tolerances for permissible leakage involves many materials in an amazing variety of solutions. And the sealing problem grows in complexity as pressures, corrosive atmospheres, humidity, temperature and speeds of rotation increase while a myriad of new evironmental factors enter each day. New complications such as nuclear radiation or the ability to seal materials that transmit infra-red or ultra-high frequency waves strain the designer's ingenuity even more.

Definition of Terms

Many definitions of seals are bandied about. The ability to resist penetration by water is called variously water-proof, water-resistant, water-barrier, impervious to water, moisture-repellant, submersion-proof, rain-tight and splash-proof. Generally what is meant by these terms is how much water passes through the seal in a certain length of time.

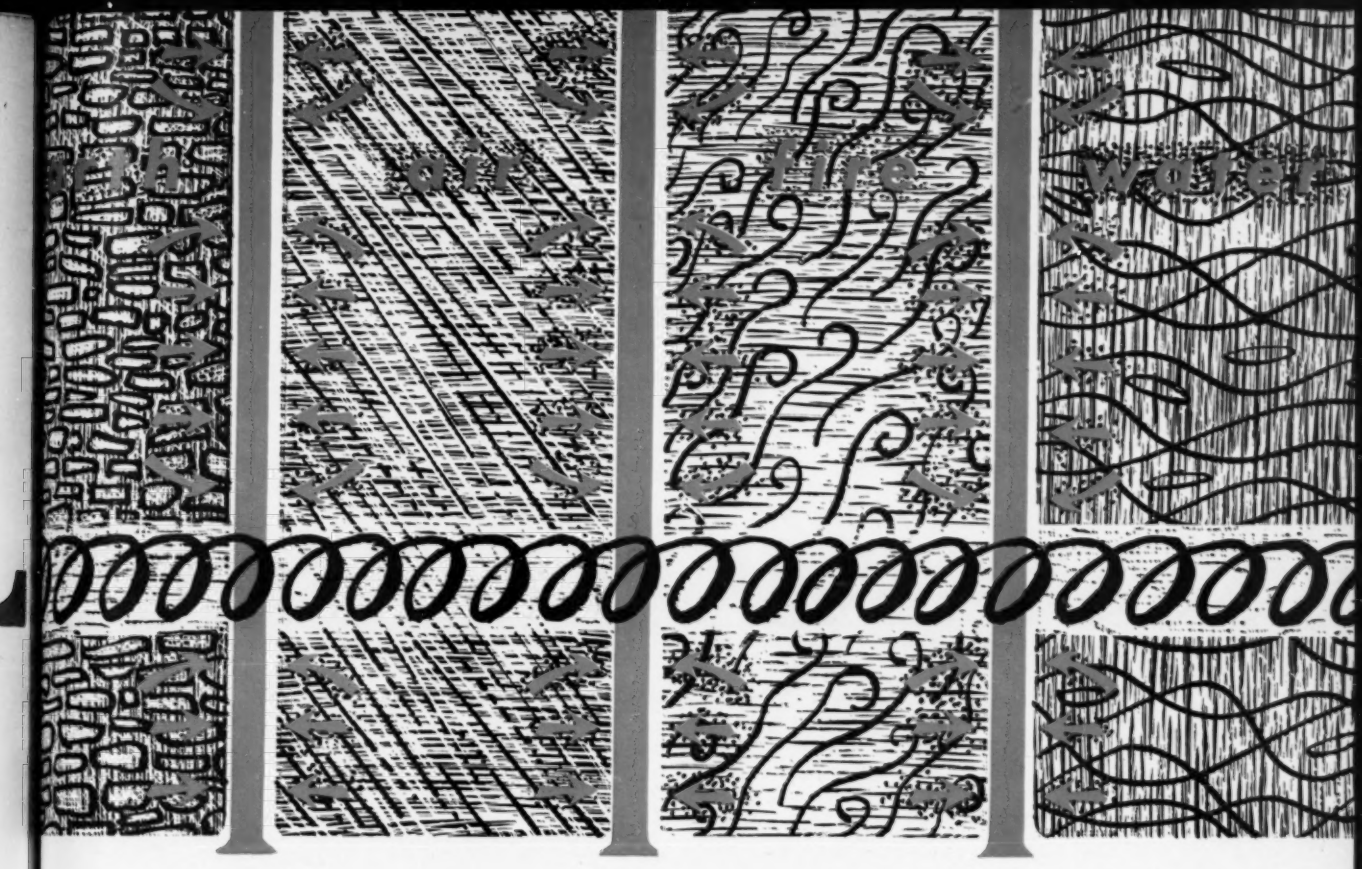
Explosion-proof doesn't mean that the seal can withstand an explosion, but that it will not facilitate an explosion. Generally, an explosion-proof seal excludes dust or some other substance that can be exploded by arcing inside a switch, relay or circuit breaker.

Another loosely handled term is hermetic. Like the words automation or engineer, hermetic has become a nearly useless word because it is used to cover such a multitude of sins. Seals ranging from careful temperature coefficient matching of glass to metal with elaborate outgassing and other precautions to pressure sealing of a gasket around a can are all described as hermetic seals. William Brown of General Hermetic Seal Corporation enumerates many aspects involved in a hermetically sealed device. According to Brown, a truly hermetic seal "requires more than a lick and a promise. It needs vacuum drying by evacuation to the micron range, outgassing, flushing with pure dry nitrogen, and back-filling with the proper inert gas mixture". He points out that permissible leak rates for hermetically sealed relays vary over a range of 1000 to 1 depending upon the particular military specifications involved.

In other words the definition of sealing requires a very exact specification of the conditions to be met and methods to be used, and cannot be defined by a few words like hermetic or water-proof.

The military organizations have been largely carrying the ball on close specification of sealing, but as Brown points out, there are wide variations in the definition of hermetic sealing even in military specs. In addition to the military, various civilian organizations such as the American Standards Association, The National Bureau of Standards and RETMA have set sealing specs.

As more engineers become familiar with military specs, they are less likely to be taken-in by the vaguer terms such as water-proof and air-tight when specifying components for commercial products. (Not only has the military made everyone conscious of defining sealing



properly but it has also stimulated research and development of new sealing materials and techniques.)

Tougher Sealing Conditions

Throughout industry the conditions of sealing are becoming tougher. Parts are much larger (generally meaning greater seal length) or much smaller (meaning smaller areas for sealing). Working temperatures and pressures are rising or falling toward new extremes*. Because of this, the materials being sealed together are different. Seals must hold back new liquids and gases with special corrosive characteristics such as radiation and ozone. Moving parts run through seals much faster.

Adding to the difficulties is the demand for less maintenance. American automobiles, to take a major example, run longer and faster between repairs. The average car contains about 30 pounds of sealers and heavy coatings —plus all the seals and piston rings under the hood.

Freedom from maintenance is also necessary when the device must operate in hard-to-reach locations. The extreme example is the telephone cable under the Atlantic. The seal must keep out sea water for the life of the amplifiers—20 years.

As the electronic industry bites off more and more of the frequency spectrum, its sealing problems multiply. Sealing materials such as Kovar that are excellent at low frequencies are too lossy at radio frequencies. For the military, all of these electronic devices must work at higher and higher altitudes. Since the voltage breakdown potential decreases markedly with increased altitude, it often becomes necessary to seal critical assemblies. These seals must then withstand the greater pressure and temperature differences asociated with these altitudes. And the last hurdle hasn't been cleared yet—nuclear aircraft mean sealing materials that must not break down under radiation.

Designers of mechanical control systems may soon be forced to expand their experience as faster-acting pneumatic systems take over from hydraulic systems. Air is more difficult to seal than fairly viscous fluids.

Many situations in industry still need a better seal than the one presently in use. For example, devices frequently require adjustment screws passing through an otherwise easily sealable case. An hermetic seal is needed for the screw threads. Packing glands, diaphragms and metal bellows have all been found wanting for reason of performance of mechanical complexity.

Materials of Sealing

French divers recently uncovered a Grecian merchant vessel that sank off the port of Marseilles more than 2000 years ago. Wine sealed in jugs with tar was found to be uncontaminated by sea water. Tars, waxes, cork, leather, resins, rubber and similiar substances readily found in nature are still widely used as sealers, but they are being rapidly replaced for many applications by newer materials such as Teflon, nylon, epoxy resins, foam-potting compounds, synthetic rubbers and metals.

The number of industries supplying sealing materials or sub-assemblies is growing steadily. For example, many companies now supply hermetically sealed headers for enclosing relays or other electro-mechanical and electronic devices.

Glass, one of the commonest materials in sealing, will

*See "New Highs in Low-Temperature Engineering", pp. 26 to 30, RESEARCH & ENGINEERING, Nov., 1956.

Checklist for Designers of Seals*

- ☐ What is being separated?
- ☐ What must pass through the seal (e.g., current conductors, light, a moving shaft)?
- ☐ Is the seal temporary, or must it last a long time?
- ☐ Does the seal have to be dismantled and reassembled over and over again?
- ☐ Must the seal have a long shelf life? (Guided missiles seals have a service life of minutes, but must have a shelf life of years.)
- ☐ To what temperature variations must it be subjected? Are the variations gradual or rapid? Are there high humidity changes associated with the variations?
- ☐ To what pressure changes must the seal be subjected? Are these changes rapid or gradual?
- ☐ What mechanical stresses are applied to the seal in manufacture and service?
- ☐ Is the seal subjected to mechanical or acoustical shock and/or vibration?
- ☐ Is continual leaking tolerable, as in the steam seal on a turbine or the hull bearing of a ship's propeller?
- ☐ What are the consequences of failure? (Very serious in a nuclear reactor or high-pressure vessel.)
- ☐ Is explosion-proofing necessary?
- ☐ Must the seal pass electromagnetic radiation?
- ☐ Must it have electrical or heat insulation qualities? Can the sealing method be used to increase heat dissipation?
- ☐ Must the seal stand high voltages?
- ☐ Are there any corona effects (ozone produced by corona deteriorates certain rubbers)?
- ☐ Are there high-altitude effects?
- ☐ Is secrecy a consideration (see section on "Double-Duty Seals")?
- ☐ What equipment is available to test the seal?
- ☐ Should an inert gas be included under the seal? (Even giant electric generators are now sealed in inert gases.)
- ☐ Do the materials sealed off release objectionable absorbed gases? Can a material be included that absorbs gases?
- ☐ Is self-sealing a consideration (as in the self-sealing gas tank for aircraft)?
- ☐ Must the seal be flexible (as in the boots over switch handles or the heating elements widely used in the aircraft industry)?
- ☐ Are the sealing materials inert to all other elements encountered in the service life of the seal? (Rubber is affected by oils and certain organic substances by fungus. Corrosion is always a problem.)
- ☐ Is there a possibility of cathodic action?
- ☐ Will the materials of the seal contribute to a fire?
- ☐ Some potting methods seal so well that if a part inside fails, you can't remove the seal to find the cause of failure.
- ☐ Are any of the materials harmful to humans? (Epoxy resins can produce dermatitis to production workers in processing, but once hardened are harmless.)
- ☐ Must the sealing material be machinable after the seal is made (as in some encapsulated electromechanical equipment)?
- ☐ Can the critical parts in the device be segregated and sealed separately?
- ☐ Are pre-formed sub-assemblies, such as headers, applicable?
- ☐ Must the seal be made rapidly in mass production?
- ☐ Miniaturization! Must your seal do one or more of the above with very small parts or in a limited space?
- ☐ Competitive costs! Must your seal do one or more of the above for the same price or cheaper than your competitors?

(*Valves and packaging are not covered in this article)

always be important because frequently you want to be able to look inside your sealed structure. However, the common glasses can't stand the higher temperatures required in the latest military applications. Soft glass vacuum tubes can be used to about 225°C; hard glass, (borosilicate) to 300° C. Beyond this limit ceramics must be considered. A few years back General Electric exhibited a ceramic tube that operated at some 500°C.

But for temperatures below those at which common glass melts or where glass cannot stand the mechanical strains, ceramics still have a long way to go before they replace glass. First, compared to glass, ceramics are expensive. Secondly, the glass industry has many years of experience in this field and has developed a wide variety of reproducible special-purpose glasses and sealing techniques, such as the expansion-match seal, the Housekeeper-type seal, the graded seal, the internal seal, various metallized glass seals, and combinations of these types. Thirdly, the glass industry has been working to extremely fine tolerances and with accurate measuring instruments, such as in the making of lenses for hundreds of years. The ceramic industry will need years to overcome the lead of the glass-makers in tolerances. In addition, there is still little standardization within the ceramic industry. The making of ceramics is still very much of an art within each company; but ceramics are superior to glass for many applications and will undoubtedly continue to replace glass in seals. However, at the same time so many applications are being found for glass in seals that glass makers need not worry.

In glass to metal, ceramic to metal and metal to metal seals, the tendency has been to eliminate gaskets and sealants and attempt direct combination between the prime parts of the seal. Yet despite the onslaught of direct-contact sealing, mechanical pressure and gasketing remain predominant methods of sealing. In the superpressure press used to make diamonds and the newly discovered borazon (see p. 22 this issue), a gasket is used to maintain pressures of 1,000,000 lb. Its nature is classified.

Teflon, nylon and the synthetic rubbers have been replacing the old gasketing materials like leather, rubber and felt, especially in high temperature and corrosive service. Yet new gasketing materials of the older substances continue to find a market. Recently an inexpensive homogenous leather gasketing material made of pulverized scrap leather was announced.

Another trend in sealing materials is combinations of materials. We now have such combinations as teflon-impregnated glass fibers, teflon-impregnated asbestos fibers and vinyl bonded to metal. The former are identical in principle to the tar-impregnated okum used to seal water out of wooden ships and boats—modern materials using old mechanical techniques. Another example of combinations is the adding of filler materials for increased dimensional stability.

Double-Duty Seals

Many seals perform a dual function in addition to sealing, and frequently the other function may be more important than the sealing itself. Whether or not an added function should be included in the seal is obviously determined by the situation. There are times when it is advantageous for a seal to be more than a seal. For example, nylon washers act both as a seal and a locking

(continued on page 37)

LITHIUM METAL *by the* GRAM *or* TON

Is your research specialty here?

The diverse physical properties and chemical reactions of lithium metal make it a uniquely valuable research tool. Consider these provocative uses:

- Alkyl-and aryl-lithium compounds, which are prepared from lithium metal, find wide application in synthetic organic chemistry. Use of methyllithium in the preparation of synthetic Vitamin A is a typical example.
- Lithium metal as a direct reducing agent now suggests an interesting potential.
- The polymerization of isoprene to "natural" rubber thru the catalytic medium of lithium metal dispersions is a new development.
- The military and peacetime uses of lithium metal in the field of heat transfer show great promise. Based on its low density, high heat capacity and high heat of fusion, lithium has no equal as a liquid metal coolant.
- Lithium metal is the starting material for the production of lithium hydride and, in turn, lithium amide and lithium aluminum hydride.
- Rocket and guided missile propellants utilize metallic "super-fuels." Many rely on complex compounds containing lithium metal or hydride. The key: lithium's tremendous reactivity.

Put lithium to work for you. Our banks of electrolytic cells can supply experimental grams or commercial tons of this admirably versatile metal. Write for details.

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CIRCLE 11 ON PAGE 48 FOR MORE INFORMATION

FACE TO FACE

R/E INTERVIEWS GOTT OF AMF ON

The special R/D problems of a company with many subsidiaries and buying more all the time

Evaluating new product ideas

Long-range product development programs

Transition engineering

Rodney C. Gott
Executive Vice President
American Machine & Foundry Co.

QUESTION: Are the duties of the top R / D people in a company rapidly acquiring subsidiaries such as AMF different than those of technical managers in a company which is just seeking to expand by increased sales and adding new products?

ANSWER: Well, they have additional duties as a result. The vice president of engineering is the senior technical adviser to the president and as such, he's not only got to run his engineering department, but he's got to advise the president on all technical questions no matter where they crop up. So that I would say that advising on acquiring other engineering activities is an additional responsibility.

Is the soundness of the research, development and engineering division of some company you're considering acquiring a very important factor when you decide whether to buy it or not?

It depends on the industry represented by the proposed acquisitions and that company's position. For instance, if that company's position depended on patents or on a royalty situation or something like that, then the engineering activity would be tremendously important. But other than that type of situation, it's just reviewed as is its manufacturing capability, sales capability, etc.

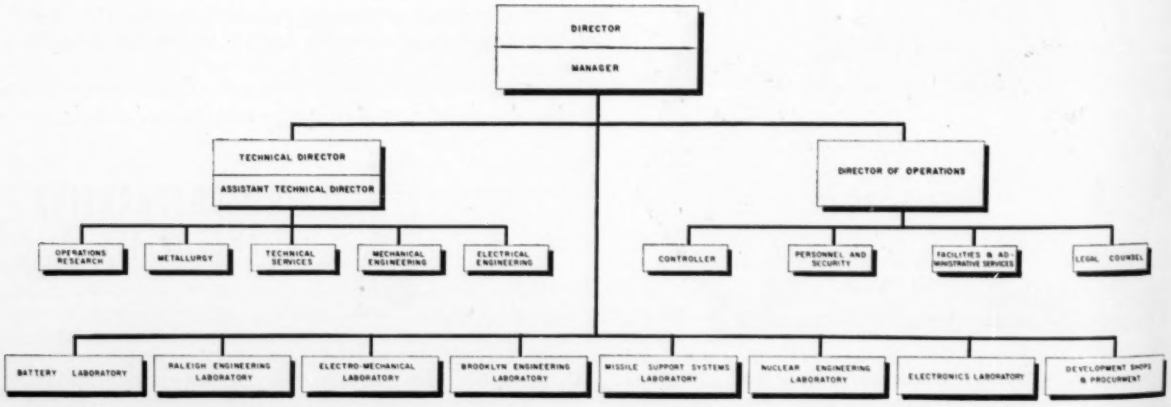
Does the V.P. of engineering ever initiate interest in a company because he is particularly impressed by their R / D capabilities and potential?

Yes, I would say that any of the staff officers in AMF can and has initiated or made suggestions about corporate acquisitions, including the V.P. of engineering.

With so many subsidiaries, how do you make sure that two or more companies are not performing the same research or developing the same product?

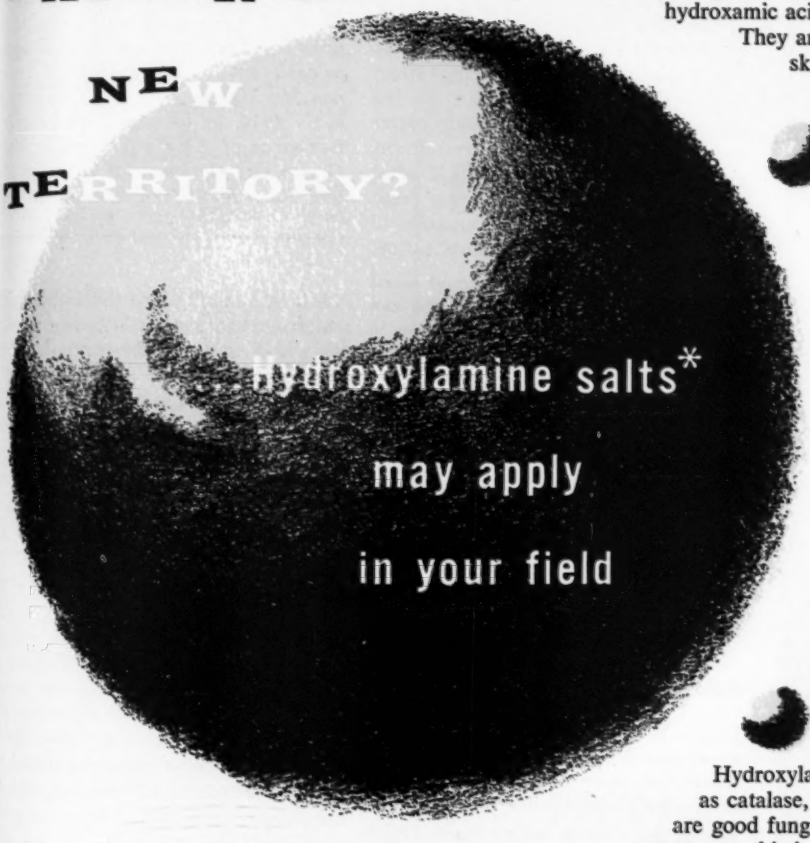
Well, that question goes into the whole type of organization we use to supervise the companies. The companies are placed into groups according to the nature of their operation. Those that apply for instance to the bowling industry are in the bowling products group; those that apply strictly to defense work are placed in the defense

(Continued on page 20)



A typical organization chart of one of AMF's engineering facilities. This breakdown between engineering staff and service staff is becoming standard in larger R/D departments.

EXPLORING NEW TERRITORY?



For synthesis—
Hydroxylamine salts may be used to make oximes, hydroxamic acids, and numerous intermediates. They are useful for preparation of anti-skinning agents, anti-rusting agents, and pharmaceuticals.

As acid-stable reducing agents— For metallic ions such as ferric, cupric, silver, and for nonmetallics such as dyes, peroxides, and nitrites. These compounds are useful in purification processes, dyeing of acrylic fibers and as a short-stopper for catalyzed polymerization reactions.

As oxidizing agents—
This is new territory that needs exploring. Hydroxylamine salts are probably mild oxidizing agents.

Effects on proteins and biological systems—
Hydroxylamine salts inhibit enzymes such as catalase, harden gelatine . . . derivatives are good fungicides and bactericides. For the most part, this is a poorly explored area suitable for intensive experimentation.

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Hydroxylammonium Chloride
$NH_2OH \cdot HCl$

Already known for their wide range of utility, these nitroparaffin derivatives may find dramatic uses from future research. Their potential applications for experimentation are almost unlimited.

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(Continued from page 18)

products group. Each of these groups has a senior V.P. supervising it. He has an engineering adviser in addition to other staff officers. The engineering adviser has two functions: one is to be thoroughly familiar with and to help organize the engineering effort in the group and secondly, to be the liaison between the group and central engineering. So he is informing the group executive at all times of what is under way either in central engineering or in any of the companies in the group, and we avoid duplication.

If you find a man of exceptional merit in the R / D lab of one subsidiary, can you move him into a better position in another subsidiary?

We not only can, but have. As a matter of fact we just completed a move like that. The chief engineer of one of the largest subsidiaries showed a capacity greater than was available there, particularly in staff work and he has been moved in as the engineering assistant to the group executive who supervises not only that subsidiary but nine others, a very much bigger job.

Committees Informal

Do you have any committees or working groups made up of all the heads of research for your subsidiaries? Do you ever bring them all together?

We do informally within each group. We do not bring the heads of all the engineering departments in the group to meet with central engineering, because, theoretically, they are performing separate functions. There is no inflexible rule that governs R/D and engineering, but we try to divide it so that the engineering units within the subsidiaries are primarily performing product engineering; whereas the pure R/D function would be retained for central engineering. This, as I say, is not inflexible and we have one or two subsidiaries that are doing R / D. They're doing it in most cases in a field which is not an active one for central engineering, so that there's no overlapping or duplication.

Evaluating New Products

How does AMF evaluate the economic worth of a proposed new product?

We have, first of all, a committee which screens new invention ideas no matter from what part of the company they come. If an engineer out in one of the engineering labs has an idea, he sends it into the Patent Committee. Its function is to see whether this idea is patentable or not. If the committee decides it is, action is taken to file a patent whether or not we're going to commercialize it right away. There's a small bonus paid to the originator. This is to encourage inventive thinking.

How would you reward an R/D idea from someone who's not in AMF?

It would go directly through to the equivalent of a new products review. Now, at the moment the new products review is somewhat informal—we have a commercial research department, but its primary function is to determine the market potential for an idea, rather than assessing its technical value. And so far, the final question of whether this is a field we want to get into, or the right product for a certain field, regardless of what its potentials are, is a matter for management's review. We're thinking quite a bit lately of making it more formal and having an actual committee set up of the top people to go through this exercise at regular intervals.

But let's assume for the moment that the outsider brings in an idea and the patent department thinks it is patentable and the commercial research department thinks there's a market for it. In that case as part of the overall summary an analysis by engineering people would be included to see how much more engineering or how much money has to be spent before it can be commercialized.

Is the patent committee made up of men who do nothing else but work on the patent committee or is that a corollary duty?

Corollary duty.

How often does it meet?

Once a month, or if the load is sufficiently great, whenever necessary.

A West Point graduate, class of '33, Bachelor of Science, Mr. Gott served two years with the Army's Corps of Engineers before resigning to join American Radiator and Standard Sanitary Corp. Recalled to the Army in 1941, he served with distinction until his release as a colonel. Starting as assistant to the president of American Machine & Foundry Company in early 1946, he became Vice President in charge of AMF's General Products Group and Commercial R / D in 1951 and Executive Vice-President in 1954.

You have the initial bonus if it is patentable. What if the product becomes profitable? Do you give the inventor or the originator some additional compensation?

There isn't any automatic reward or bonus for this additional result, but if the idea was particularly good and it was patentable and it turned out to be successful, obviously the originator is in a preferred position regarding his own job and salary. There isn't any automatic reward or bonus.

How would you reward a researcher who is not connected with new product development but has been exceptionally creative?

By salary increases and promotion.

Have you reached any conclusions on what the optimum size of an R / D lab should be?

No sir! Our problem is complicated by the fact that, at the moment, some 75% of our central engineering activity is spent on government work, which has tended to exaggerate the size of the engineering department, Therefore, our R / D activities are determined not only by the demands of our proprietary position, but by the volume of government work we elect to go after.

What would AMF do with its engineers if the government cut down on military expenditures?

What we would do would depend on the degree to which the government cut back.

You wouldn't attempt to distribute those engineers among your subsidiaries?

Yes, to the maximum extent possible. However, a severe cutback would undoubtedly force us to curtail some of our engineering activities.

Long-Range Product Development

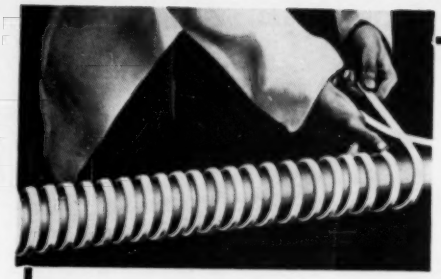
Do you have a long range, say five-year, product development program?

We do have in certain product lines. As far as the company as a whole is concerned, we have five-year forecasts —relatively new to the company— which not only help to define the existing activities in each of the business units, but very often point a finger at areas where new products are necessary. As we get more and more into this long-range forecasting, I am sure that out of it will come more long-range new product programs.

How frequently do you formally evaluate the progress of a long-term R / D project?

Well, the government projects take

(Continued on page 27)



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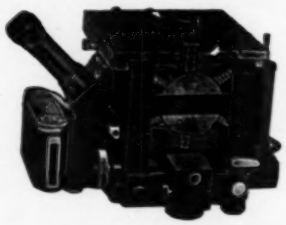

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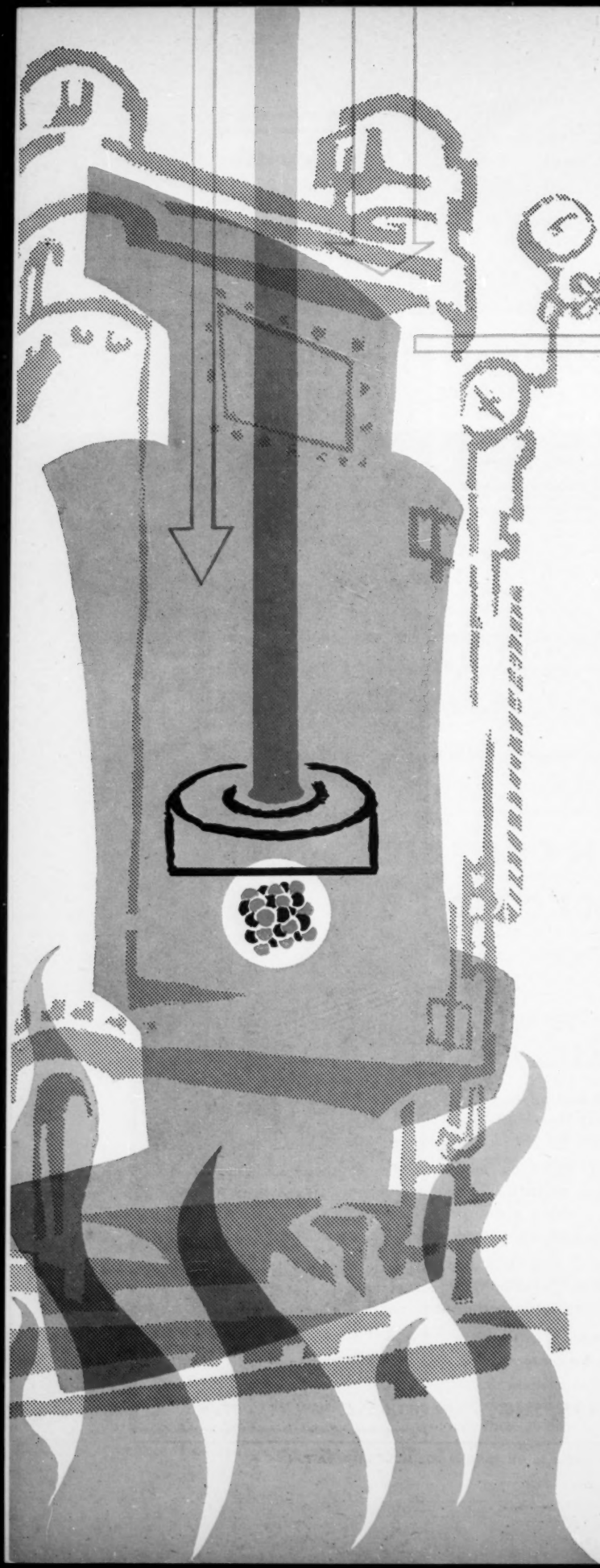


LAWRENCE SANDEK, associate editor

tho

The Philosopher's Stone is a thousand-ton press with a million-pound squeeze.

Our alchemist forbears sought a magical substance that would transmute base metals into gold. They expected to find a stone or chemical or elixir. They died with their dreams on.

Two years ago, a team of lineal descendants of the ancient breed, working at General Electric's Research Laboratory in Schenectady, found the elusive secret—with some modifications. Instead of a base metal, a carbonaceous compound was used. And a huge hydraulic press, like an obedient genie, accomplished the transmutation. The result was not gold, it was diamonds.

Carbon : Diamond :: Boron : Borazon

A few weeks ago GE announced the synthesizing of a substance as hard as diamond: a substance that does not appear in nature. They call it borazon. The accomplishment is a side-effect of a continuing research of the high-temperature, high-pressure phenomena that produced the synthetic diamonds.

Men have tried to make diamonds for over a century. One of the most interesting attempts was made by the Frenchman Henri Moissan in 1894. Moissan used sugar charcoal, as a close approximation to carbon; dissolved it in molten iron, for heat; and then quenched the solution in cold water. The pressure generated by rapidly cooling the mass was supposed to have crystallized the carbon. When the metal was dissolved from the solidified mass, traces of transparent material remained that had optical properties similar to diamond's and the stuff gave off carbon dioxide when burned. Moissan believed he had made diamond.

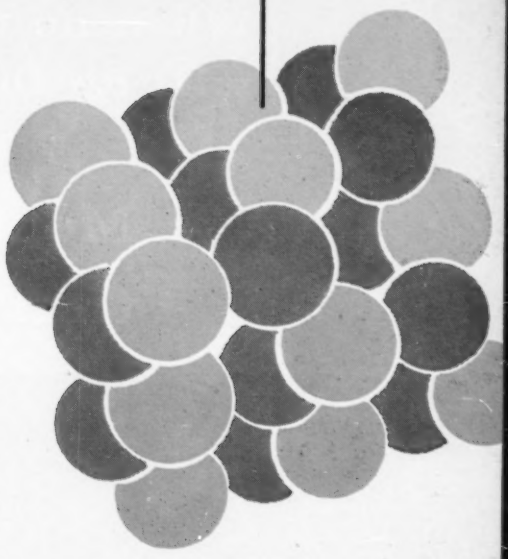
His work was at first confirmed and then doubted. The general assumption for the last 50 years has been that neither Moissan nor any of the other earlier experimenters had succeeded in making diamond.

Sustained Pressure Main Problem

The accomplishment of even the most simple technological ends requires the solution of a whole complex of subordinate problems. The central problem in all attempts to make diamond had been obtaining sustained pressures in the region between 600,000 to 1½ million psi. This is the problem Moissan tried to solve with his molten iron experiment.

Practically all ultra-high-pressure devices are based on the piston-cylinder principle. The substance to be pressured is placed in a cylinder into which the piston slides. In all cases the pressure vessel is the limiting factor: there is force aplenty to generate the pressures but cylinders and pistons had always leaked or bent. Beyond a certain point thickening of the vessel walls

borazon story



contributes little to its pressure-holding ability.

The successful pressure vessel was finally made by a combination of techniques. Fundamental among these was the adoption by GE's Dr. H. T. Hall of a method devised by Professor P. W. Bridgmen of Harvard. This was the use of multiple shrink bands on the cylinder—a technique used years ago in making large gun barrels—and special sealing gaskets between the cylinder and piston. In addition, new ways of distributing parts were developed. The resultant pressure vessel could sustain pressures in excess of 1½ million psi and temperatures up to about 5000°F for several hours.

Measures by Sharp Phase Transitions

These enormous pressures and temperatures are measured by observing the sharp phase transitions that some metals undergo at definite pressures.

In the metals used in these experiments the transitions are accompanied by abrupt changes in electrical resistance. The resistance of bismuth metal, for example, rises slowly with pressure until 365,000 psi is reached, then it drops abruptly to a second level, and at about 397,000 psi it again changes abruptly to another value. In calibrating a pressure chamber, a bismuth wire with suitable electrical connections is incorporated in the chamber. The press force required to cause the bismuth to change resistance corresponds to a known pressure.

Other metals provide calibration points too: thallium at 640,000 psi, cesium at 785,000 psi, and barium at 1,140,000 psi. Temperatures inside the pressure vessels are measured by use of thermocouples, melting points of materials, Curie points of magnetic materials, thermocolor paints, and the same change in electrical resistance of wires used in determining pressures.

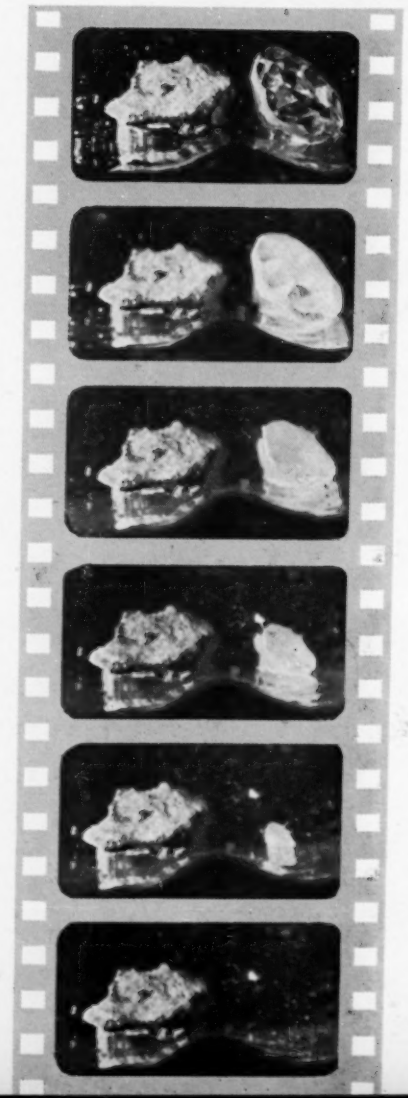
Finally, in February of 1955, the synthesizing of diamond was announced: man-made diamond made of carbon, temperature and pressure, ingenuity and 125 years of experiment. The extension of the same methods resulted in the discovery of borazon.

Borazon: Diamondlike Nondiamond

Dr. Robert H. Wentorf is a soft-spoken man of 30. He was a member of the earlier team that produced synthetic diamond. He is also the GE scientist who discovered borazon. In speaking of his discovery, he throws it into the relief of a continuing investigation. He looks upon it not at all as a culminating achievement.

Borazon is made of boron and nitrogen, which lie on either side of carbon in the periodic table. Boron and nitrogen commonly are found in a combined form called hexagonal boron nitride. This substance resembles

(*Continued on page 26*)



When chamber temperature reaches 1600°F, diamond, right, oxidizes. Borazon, left, withstands temperatures in excess of 3500°.

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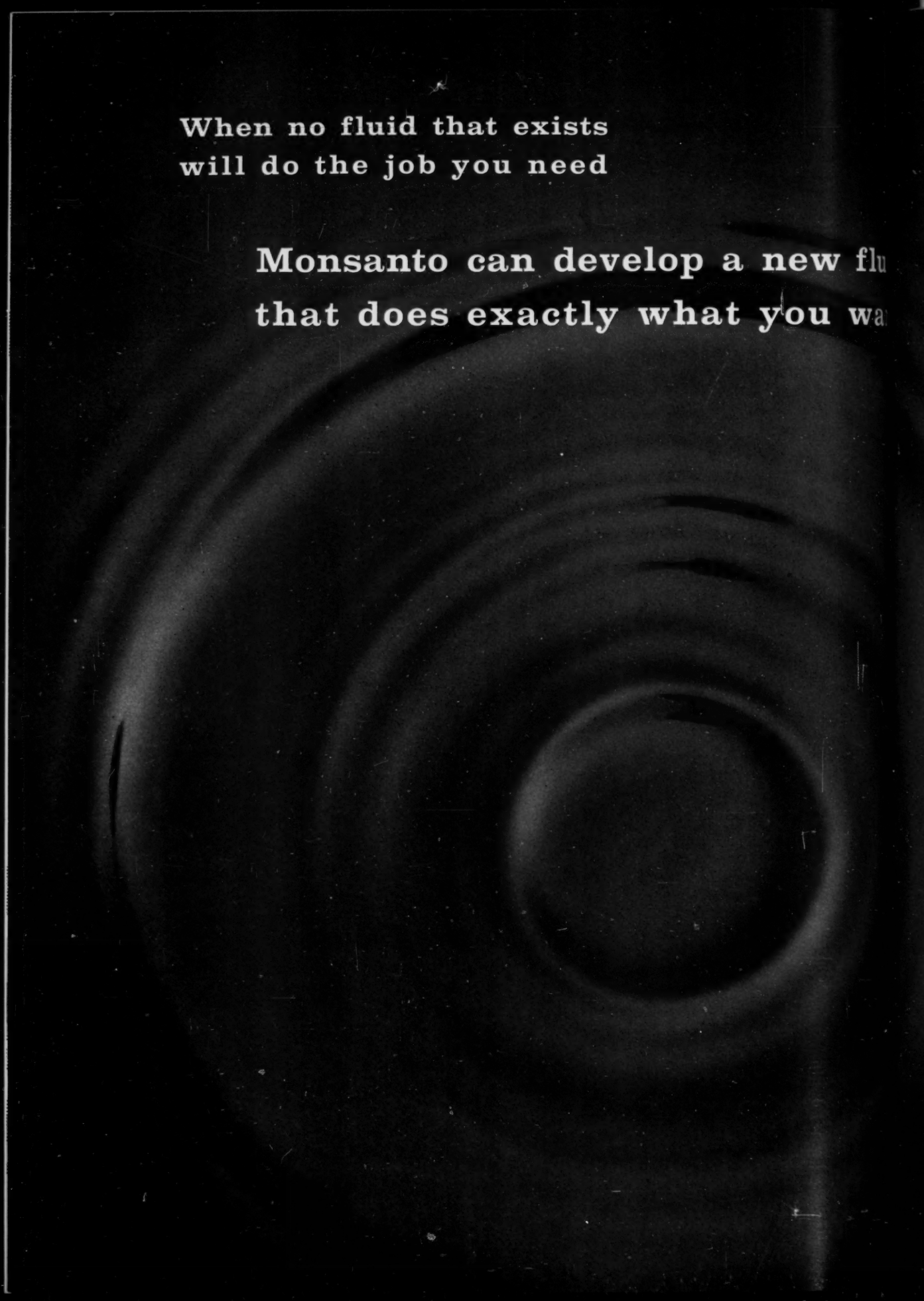

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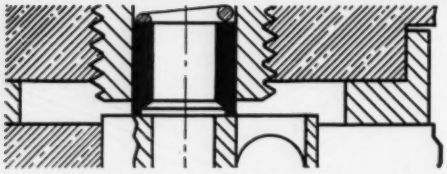

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the Borazon story—

Continued from p. 23

graphite; it is slippery and soft and is sometimes nicknamed white graphite. It is slippery because in its crystalline structure its carbon atoms are tied together in sheets or layers. And though the sheets are firm within themselves, they are not tightly bound to each other, so that slight mechanical pressure causes the sheets to slip (if they slip when we want them to we call it lubrication). To fasten the layers of hexagonal boron nitride to each other as securely as each layer is bound to itself, additional electrons are needed to make the bond. The form of hexagonal boron nitride would in the process be changed to cubic boron nitride.

In the process of bonding the free nitrogen electrons to the boron, precise control is necessary. Carbon, among other substances, crystallizes in more forms than one, depending on pressure and temperature.

"Trying to do that", Dr. Wentorf says, "was in a way like trying to catch a new, special kind of fish in a strange lake. You weren't sure whether that lake had any such fish or whether any lake had such fish; and other fishermen were dubious."

But borazon came to be. The electrons needed for bonding the boron sheets together were donated by the nitrogen when the two were subjected to a million psi of pressure and 3000°F of heat. The cubical-patterned borazon structure is like diamond. X-ray diffraction tests on borazon show that the alternate atoms of boron and nitrogen are packed together almost as closely as the carbon atoms in diamond. And borazon's density is about the same as diamond's—specific gravity for borazon is 3.45, for diamond, about 3.53. Borazon is superior to diamond in temperature resistance: diamond burns at 1600°F, borazon survives 3500°.

The name of the diamondlike substance is a wedding of *bor-*, from boron, and *-azon*, from azo, a chemical reference to nitrogen. Borazon usually occurs in black, brown, or dark red, though it has been made in white, grey, and yellow. The color depends on the boron-nitrogen ratio. The crystals generally are small, about 1/32", but they sometimes grow together to form strong lumps about the size of a pencil eraser.

By-Product not End-Product

Though borazon offers possibilities for industrial uses usually associated with diamond, GE's evaluation is that it represents less a product than a technique for further investigation into high-pressure, high-temperature research. Dr. A. J. Nerad, a member of the team that produced synthetic diamond two years ago, sums up: "We look to the superpressure techniques to yield new forms of matter with properties of scientific value. The structural changes, the phase changes, and the chemical reactions, that occur only at superpressures represent a wide field for scientific attention. . . The great depths of the earth constitute a vast superpressure cell with estimated temperature rises of about 105°F per mile. . . In the laboratory superpressure cell, the temperature may be lowered while the pressure is maintained. Thus we expect to obtain forms not found in nature."

Dr. Wentorf is continuing his research. He is seeking more precise data about crystal growth in high-temperature and high pressure environments and the effects of various "impurities" on crystal growth. Research is the investigation of possibility: Dr. Wentorf is pushing the impossible. END

FACE TO FACE

CONTINUED FROM P. 21

care of themselves. Let's take for instance the Talos' ground-launching system, which is a three-year program. The specifications and the time schedule force an evaulation at periodic intervals. You're supposed to finish a certain phase, at a certain time within a certain amount of money. It has to be evaluated at that point. Now in the proprietary fields, this evaluation is mostly done by the head of the business unit who is buying the engineering project from Central Engineering.

But you have no set three-month or six-month evaluation?

Yes! Within engineering. They have their own regular monthly review. They have a meeting of project heads to evaluate progress. But as far as the outside divisions are concerned on proprietary work, they're constantly in touch with it, pushing it all the time. So it's an irregular but informal evaulation that goes on all the time.

How frequently does top management receive reports on the status of R / D?

We have a monthly report—a progress report which is very complete and covers every single project in Central Engineering.

There is no specific annual report on R / D?

Not as such because the monthly reports are very complete.

Transition Engineering

Are you particularly interested in the problem of transition engineering, the movement of a product from R / D, through engineering, into production?

We are and always have been. A project engineer is assigned to the project from the incubator stage to the time when drawings are furnished to production. He then assists in the transition into production.

If the man who's been in charge of this product is particularly interested in it, would you let him stick with it right into production? Let him aid in the production of the product?

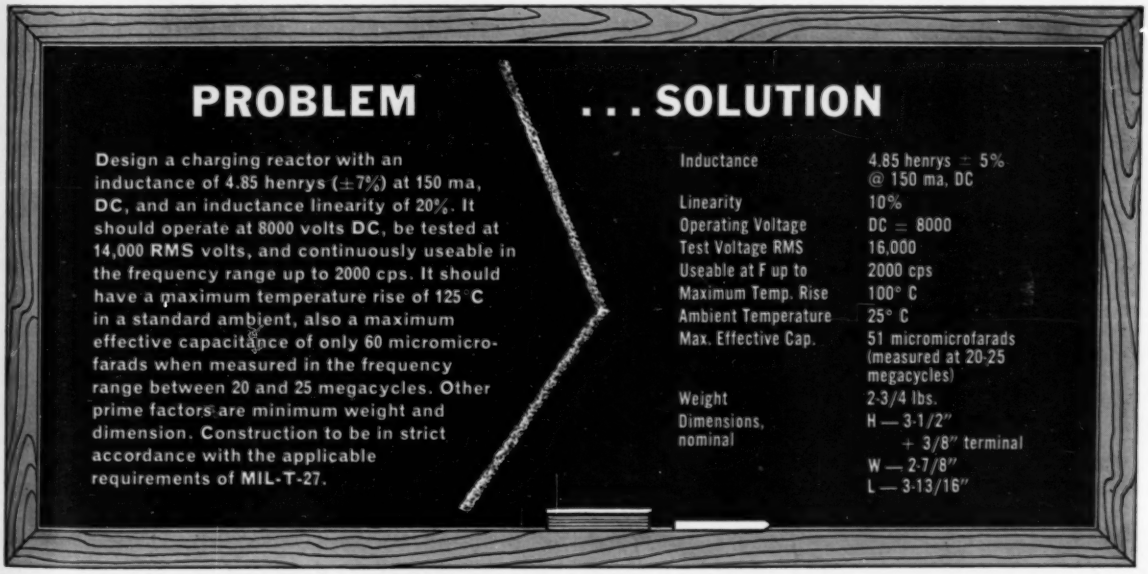
Well, he is consulted directly right through the first-lot production, because the first lot is never completely free of bugs. So in effect, he is in practical charge right through there. Now, it might also turn out that if his contribution was more in the area of product engineering than it was research and development, on this particular product, he might become a part of the business unit. We are attempting to organize more and more on a basis of putting product engineering in the business unit than as a part of central R / D.

Many companies are now starting to encourage their engineers and researchers to write articles on their work. They feel this is just part of their duty. Do you have any program or prizes or time off to write articles?

No, but there is a great deal of it that is done and it is encouraged. Engineers not only write articles, but attend seminars, and go to outside educational courses. An engineer gets paid by seeing his article in print in most cases. The pride of authorship is the principal reward because a paper read before a national technical society or published in a leading trade magazine brings professional recognition both inside and outside AMF.

Thank you, Mr. Gott!

Mr. Gott was interviewed by Melvin Mandell, Editor of RESEARCH & ENGINEERING.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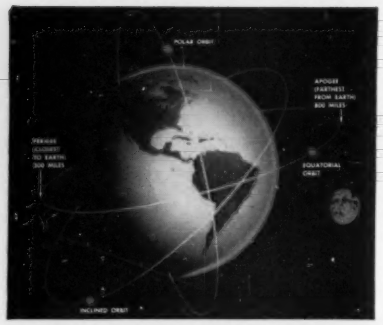
MATERIALS



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New stability for satellite tracker

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A few millivolts power-supply drift can mean a large range or angle error in tracking the U. S. Navy's satellite missile—built for the International Geophysical Year.

It's for this reason that voltage regulated power supplies for the tracking equipment must be as stable and as drift-free as the state of the art permits, over a very wide range of operating conditions.

That, in brief, is the problem that faced engineers at Power Designs Inc., Richmond Hill, N. Y., builders of regulated power supplies for the satellite tracking equipment.

To make the problem really tough, however, maximum reliability required that failure of any component not damage any other component. Certain vacuum tube failures, for example, subjected ordinary precision resistors to an 8 to 10 times overload. The resistors charred, opened up. Some even blew up, literally!

Engineers at Power Designs got together with Ward Leonard engineers and came up with the answer: A special Ward Leonard Vitrohm resistor that had all the drift-free stability required plus the overload capacity that makes Vitrohm resistors a favorite among designers. More economical, too.

This, of course, is added testimony to the facts we've known all along about Ward Leonard Vitrohm resistors. And, it shows the cooperation you can expect when you bring your special problems to Ward Leonard's application department.

We predict, too, that you'll be hearing more about these special high-stability Ward Leonard Vitrohm resistors. Particularly if you're concerned with analog or digital computers, acquisition or tracking equipment, instrumentation or other application requiring the utmost in stability plus high overload insurance. For more data *now* write: Ward Leonard Electric Co., 12 South Street, Mount Vernon, N. Y. (In Canada: Ward Leonard of Canada Ltd., Toronto.) 7.2

LIVE BETTER...*Electrically*

CIRCLE 31 ON PAGE 48 FOR MORE INFORMATION

High-Lustre Aluminum

Tests show that reflectivity of a high purity anodized aluminum, called Lurium, remains relatively unimpaired after 40 weeks of exposure to an industrial atmosphere. Its total reflectivity, expressed as a percentage of a silvered mirror, is 84.0% as against 65% for EC grade aluminum, 69.1% for rhodium plated nickel and 63% for chrome plated steel. Corrosion resistance tests show a loss by weight for Lurium in a 38% aqueous solution of hydrochloric acid of 9 milligrams per square decimeter per day as against 48,000 for EC grade aluminum. This alloy can be anodized and dyed to simulate gold, silver, brass, platinum and other metals. Fromson Orban Co., 261 Madison Ave., N.Y.C.

CIRCLE 32 ON PAGE 48 FOR MORE INFORMATION

Pure Titanium Powder

The latest phase for the development of pure titanium powder has been completed. Its soft, sponge-like particles can be formed by powder metallurgy into corrosion and erosion resistant parts at costs significantly lower than by machining from solid titanium. The powder, called UniFide, has a very low oxygen content and remarkable stability in air. This enables it to be shipped dry and handled with only ordinary precautions, whereas other titanium powders must be shipped under water and handled with great care. Applications include cutting tools, titanizing, as a chemical reagent and as a pigment. United International Research, Inc., 38-15 30th St., Long Island City 1, N.Y.

CIRCLE 33 ON PAGE 48 FOR MORE INFORMATION

Strong Steel Tubes

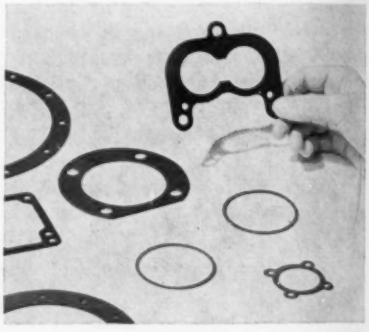
Precipitation hardening stainless steel has been introduced in tubular form. With high strength-to-weight ratio, it is useful in applications demanding a combination of corrosion resistance, light weight and high strength. At elevated temperatures, the alloy may be used as a structurally light metal such as titanium, aluminum, magnesium and the like. In the hardened condition, the steel has higher mechanical properties than any of the chromium-nickel stainless steels. Typical analysis of 17-7PH steel is: carbon —0.07; chromium —17.00; nickel—7.00; aluminum—1.00. Carpenter Steel Co., Alloy Tube Div., Union, N.J.

CIRCLE 34 ON PAGE 48 FOR MORE INFORMATION

Magnesium Oxide Tubes

Magnesium oxide, for insulating electric resistance wire inside the metal sheath of a heating element, is available in tube form. Made in specified diameter and length, with one or two through holes for the wire, it completely fills the sheath tube and is much simpler to insert than granular insulation. It crushes uniformly when the sheath is swedged. The material is an excellent heat conductor and is suited for service at temperatures up to 1900°F. Saxonburg Ceramics, Dept., 18 Mg, Saxonburg, Pa.

CIRCLE 35 ON PAGE 48 FOR MORE INFORMATION



Homogenous Cork Gasket

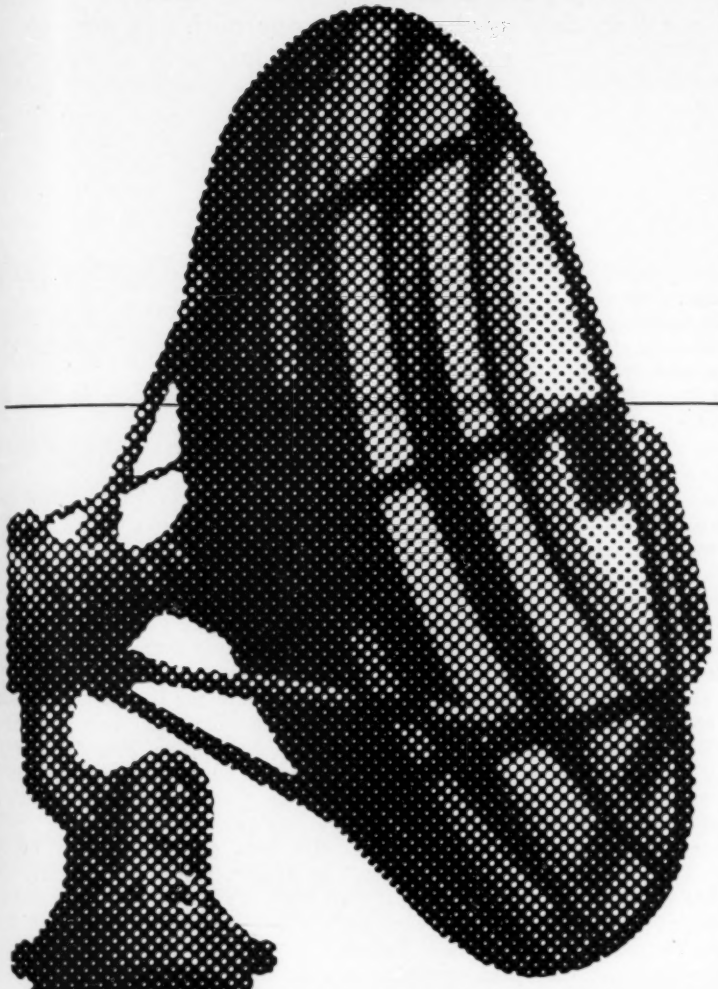
An unusual gasketing material is composed of cork granules and wood fibers bound together with Goodyear's Chemigum nitrile latex. The soft, compressive nature of Kaokork makes it ideal for delicate seals, as well as those having rough surfaces; or thin-sectioned housings with sharp edges. The combination of cork, fiber and rubber means that "tailor-made" gaskets can be made for specific requirements, by altering the ratios of the components. Oil resistance of the rubber used in this material makes it suitable for applications where oil is a problem. Kaokork is available in sheet stock up to 100 inches wide and from 15 to 45 points in thickness. F. D. Farnam Co., Chicago, Ill.

CIRCLE 36 ON PAGE 48 FOR MORE INFORMATION

Nylon Bonding Agent

An epoxy-based compound designed to bond Nylon to itself, to metal or other materials, has been announced. Bonding Agent R-323 possesses high bond and peel strength, and can be used with rubber. Carl H. Biggs Co., 2255 Barry Ave., W. Los Angeles, Calif.

CIRCLE 37 ON PAGE 48 FOR MORE INFORMATION



FROM DATA TO DIGITS...

Today Hughes is developing systems which convert radar data and other information to digital form and process it for use in performing control functions.

These systems will be able to receive and store vast quantities of data from many different sources and distribute it, after processing, over large and complex ground nets.

Special-purpose digital computers are employed, utilizing magnetic drum memory and novel programming techniques. The systems will also include visual displays and employ the latest concepts of human engineering to simplify equipment operation and minimize the possibility of human error. Vacuum tubes are being replaced by transistors or ferrite cores in flip-flops, registers, and amplifiers; and diode matrices are being replaced by ferro-magnetic circuitry.

These and other features of the new systems promise to maintain and extend Hughes leadership in the fields of digital computers and processing systems. In order to design and build these and future systems, Hughes requires engineers with experience in electronic circuit design, logical design, electronic packaging, radar systems, and many others.

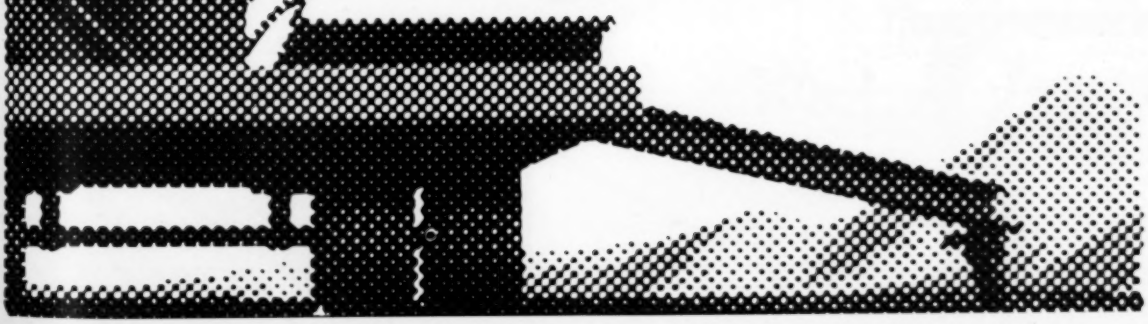
For further information write us at the address below.

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

SCIENTIFIC STAFF RELATIONS

Hughes Aircraft Company, Culver City, Calif.



No research problem, however knotty, can long defy solution with an approach like the one used in this case-history

the Klugemacher's

MERVYN MAGNIN hummed a gay tune as he waited for the entrance of his chief engineer, Otis Bates. And well he might. Sales were booming at Integrated Electronics, production was only one year behind, and now that the Kluge project was started, the outlook was very bright indeed. As Magnin hummed, he stretched his legs in contentment and gazed out upon his rapidly growing empire.

Off to the left was the wire enclosed domain, Yard A, where the individual sections of the super-secret Kluge were constructed. Across the highway to his right was Yard B, a jewel in a sunlit valley of Southern California. Here is where the sections from Yard A were brought to be assembled into the world's first land-based Kluge—a device so secret that only Mervyn Magnin, the Research Director, knew what it was. And in the middle of Yard B, rising up straight and mysterious, was the partially completed Kluge. The project was moving along smoothly, and at the present rate the Kluge would be completed well within the projected deadline. It is small wonder then, that he turned to his old friend, Otis Bates, with a cheery eye and a hearty greeting.

Now Otis Bates, a top-notch engineer, was normally a person of happy demeanor who responded to a hearty greeting with a heartier one. Today, however, there was something on his mind.

"Merv," he said, "that damned Kluge has developed a pulse dribble through one of the grommets. There's no explanation for it, and nobody knows how to trouble-shoot it."

Mervyn Magnin was more amused than alarmed. "Get in touch with our spy at International Multiplex and see what they've done."

"I already have. They've gone completely over to analog. There's nobody there who knows anything about the business."

"Well, get somebody down to Autodata and see what they're doing."

"They've got a man in our plant trying to find out what we're doing."

By now Mervyn was beginning to worry. "How about Standard Decision Element? They ought to know. They had the Kluge concept originally."

Bates shook his head. "They're no help either. Remember when we appropriated the idea from them? We offered their engineers the square of their salary. They don't have a single man left over there who ever worked on the Project. I tell you, Merv, there's no way out."

It took a long silent minute for the import of Bates' words to penetrate into his inner consciousness. And for another long silent minute Mervyn Magnin struggled with his soul. When at last he spoke, his voice was low and choked with emotion. "Very well then," he all but whispered. "We'll get our own solution!"

Bates recoiled. His eyes grew wide and his jaw dropped! "Merv," he gasped, "you can't possibly mean what you're saying. Why, it's unthinkable. An organization like ours can't afford to do any original thinking. You know company policy. . . . 'It's cheaper to buy it than dream it up'. Besides, it's completely out of the question to expect our engineers to do it. This is their

intellectual home, a place of academic atmosphere where their fine engineering minds can push forward the broad frontiers of knowledge. It says so in our ads, and we've written it in their contracts. If we were to assign any of them to anything so menial as a practical subject, we'd never get another engineer to work for us."

"I know," said Mervyn slowly, "but I'm thinking of something else. One of those Creative Thinking companies. Ever heard of an outfit called Lancelot Large Associates? They're a group of experts who specialize in all kinds of problem solving. These boys beam solutions out of their eyes. Just tell them your troubles and before you know it you haven't a care in the world."

"Merv," said Otis Bates, "you've restored my faith in Integrated Electronics. I'll get in touch with them right away."

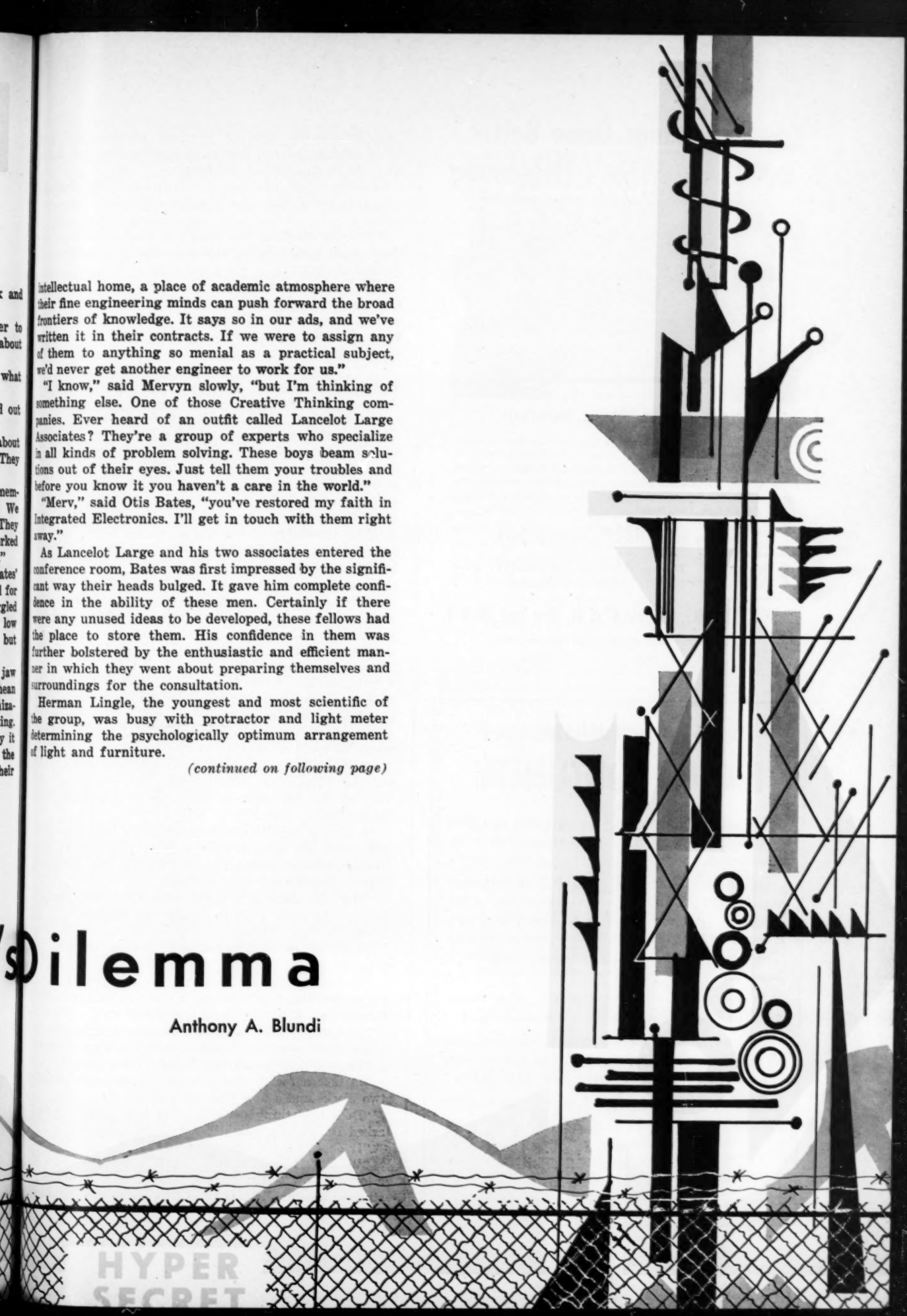
As Lancelot Large and his two associates entered the conference room, Bates was first impressed by the significant way their heads bulged. It gave him complete confidence in the ability of these men. Certainly if there were any unused ideas to be developed, these fellows had the place to store them. His confidence in them was further bolstered by the enthusiastic and efficient manner in which they went about preparing themselves and surroundings for the consultation.

Herman Lingle, the youngest and most scientific of the group, was busy with protractor and light meter determining the psychologically optimum arrangement of light and furniture.

(continued on following page)

ilemma

Anthony A. Blundi



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Qualifications must include a B.S. in Engineering and proven ability in the supervision of engineering personnel. Ability to coordinate work efforts with the efforts of other groups, departments, companies, and government agencies is essential.

Experience in electro-mechanical, office equipment or photographic fields would be helpful.

Imagination and inventiveness is required, plus the capacity for personal growth in a pioneering organization located in upper New York State.

Please submit resume and salary requirements to:

Box C-1
RESEARCH & ENGINEERING
103 Park Avenue
New York 17, N. Y.

Dr. Spreck, the oldest of the group, recited the alphabet in random order so that he might free his mind from any ruts or stereotyped thinking.

Lancelot Large, who was always in condition, chatted with Otis Bates while the others finished their preparations.

When the meeting was ready to start, the four of them sat at a conference table and Otis Bates addressed the group:

"Gentlemen, I have asked you here to consult on a grave and difficult problem. It is one which involves, not only the success of a huge project, but also the future of Dr. Magnin and myself. It seems that this land-based Kluge which we are building has developed a pulse dribble through a grommet . . ."

"Please, Mr. Bates," interrupted Lancelot Large, "we do not wish to hear your problem. As I explained to you, our method here is to provide a General Purpose Solution; one that is independent of the problem, and one that does not need a distressing set of conditions before it can be applied. We find that in this manner, we are able to satisfy not only those with difficulties, but we can also render assistance to those who have no problems at all. Therefore, we would prefer to work on your case with no knowledge of the circumstances which led you to consult us. However, since you've let the cat out of the bag . . ."

"They had a cat in the bag?" asked Dr. Spreck, whose mind was trained to attach equal importance to all statements. "Whatever for? My sister has 27 cats and a kitten. I don't recall ever seeing one of them in a bag."

"We were not talking about cats," said Otis Bates. "Mr. Large happened to remark . . ."

"Please, Mr. Bates," reprimanded Lancelot Large, "there will be no critical remarks during this stage of the solution. We are merely bringing forth ideas in order to stimulate each other's imaginations. If Dr. Spreck wants to speak of cats, he is encouraged to do so."

"Quite right," murmured Dr. Spreck, who was slightly put out. "Important subject, cats. Do you know that 79% of the fur coats in this country are made from cat fur?"

"Is that a fact?" said Herman Lingle, who was quite impressed and quickly drew a block diagram to show its significance. Meanwhile, Dr. Spreck was breathing heavily through the nose at Bates.

"You say there is a pulse dribble?" asked Lancelot Large, who knew when to change the subject.

"That's right, through the grommet."

"Could it be that someone is tampering with the object?"

"Oh, no!" exclaimed Otis, "we keep it guarded at all times. Besides, it is standing in the very center of Yard B, and Yard B is completely fenced in."

"You speak of Yard B," said Herman Lingle, who had a keen incisive mind. "I take it, then, there's a Yard A?"

"Oh yes, indeed, and that is also fenced in."

"Is that a fact?" said Herman Lingle, and he added two blocks and a flow line to his diagram.

"Does this thing make a noise like a cat's meow?" asked Dr. Spreck, still sticking to the subject.

"It doesn't make any noise at all."

"Well, if it made a noise would it make a noise like a cat's meow?" Dr. Spreck was a man who liked a straight answer. By this time, Otis Bates was completely

confused, but he remembered Lancelot Large's admonition that there must be no critical evaluation at this stage, and decided that he could play this game too.

"No, it would not," he replied. "It could roar like a rat."

"Oh my goodness!" exclaimed Dr. Spreck, "then you've doubled the problem: rats reproduce twice as fast as cats."

"Is that a fact?" said Herman Lingle who was now working on a four-dimensional nomograph in three colors.

Otis Bates looked imploringly at Lancelot Large. He was near his breaking point. Large, however, reassured him. "I believe we have brain-warmed the question sufficiently, Mr. Bates. My associates and I will now discuss it privately and tomorrow will present you with a solution. Otis Bates reeled from the room and reported to Mervyn Magnin.

The next morning the two were waiting fearfully for the arrival of Lancelot Large. He arrived promptly at 10:45 AM, smiling reassuringly.

"Dr. Magnin," he began, "we have worked hard on your problem and I am happy to say that we have come up with a solution which I am sure you will find to your complete satisfaction. Thereupon he brought forth a typewritten document and began to read . . .

"The facts of the case are these:

1. Cat pelts are very valuable as furs.
2. Yard B is completely fenced in.
3. Cats multiply rapidly, but rats multiply twice as fast as cats.
4. Yard A is completely fenced in.

We recommend, therefore, that you keep cats in Yard B, and rats in Yard A. Let them multiply, each in their own enclosures. When there is a surplus of rats, transfer them to Yard B, where the cats will eat them.

"Then, when the cats have become fat and sleek, skin some of them and sell the pelts to the fur industry. Take the carcasses of these skinned cats and let the rats eat them. In this way, the rats feed the cats and the cats feed the rats. There is no overhead and all profit. This we believe is the solution to your problem."

Mervyn Magnin was overcome with emotion. The simplicity and elegance of the solution touched him almost as deeply as the profit the company would get from the cat pelts. He wept tears of gratitude as he offered his thanks.

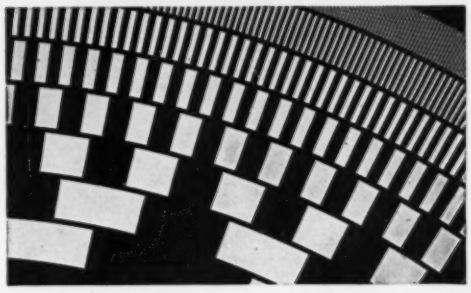
"It was nothing," replied Lancelot modestly. "We merely applied the principles of Feedback to your problem and the solution was obvious."

And so ended the Klugemacher's Dilemma. The sun is still shining on the Integrated Cat Pelt Corporation. Across the highway to the right is Yard B. In the middle of Yard B, rising up straight and mysterious is the partially completed Kluge. It is swarming with cats, and there is still a pulse dribble through one of its grommets.

But it is no longer a problem! END

Anthony A. Blundi is Supervisor of Advertising and Promotion for the Electronic Instruments Division of Burroughs Corporation, Philadelphia, Pa. Starting with a background in mathematics, Mr. Blundi moved into his present post from technical writing.

Gurley Standard Binary Code Discs Now Available in Four Versions



Gurley, manufacturer of the *standard* binary code disc for the electronics industries, is now able to supply four versions for use in either photo-electric, magnetic or contact types of pickups.

Containing concentric zones of information in the gray (reflected) code, the Gurley discs contain alternate clear and opaque sectors. Thin annular rings separating adjacent zones are opaque. Varying patterns record up to 8192 bits of information (65,536 on special designs!).

Four coatings are available: "Type T"—photoengraver's glue with colloidal (black) silver, essentially grainless; "Type R" with etched metal coating, for reflectivity and transmission contrast; "Type M" with chemically deposited ferrous alloy possessing both *magnetic* and optical transmission contrast; and "Type C"—metal bonded on glass for electrical *contact* use as well as in contrast of optical transmission. WRITE FOR BULLETIN 7000.

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The Problem:

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The Solution:

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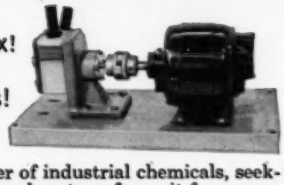


A large producer of industrial chemicals, seeking a portable carboy transfer unit for pumping concentrated HCL, solved his problem with a self priming Vanton "flex-i-liner" pump, Model XB-P30 (5 GPM). The polyethylene body block and Hypalon "flex-i-liner" are the only materials in contact with the fluid, and the design eliminates stuffing boxes and shaft seals. Pump and base are mounted on casters for portability. Maintenance has been reduced to annual replacement of the inexpensive "flex-i-liner".

For pumping corrosive fluids, abrasive slurries, and fluids which require no contamination, Vanton is a natural.

Catalog R3 on request.

VANTON
PUMP & EQUIPMENT CORP.
201 Sweetland Ave. Hillside, N. J.
division of Cooper Alloy Corporation

CIRCLE 30 ON PAGE 48 FOR MORE INFORMATION

making the most of Committees

(Continued from page 12)

who have the opportunity to recommend, suggest, and criticize a plan beforehand are much more likely to play their role wholeheartedly.

7. Prepare an Agenda in Advance

One of the reasons why committee meetings are frustrating is that they so frequently end in deadlock. Often the final outcome is a vote that the problem either be held, investigated further, or postponed till a later date. Despaired one R/D manager, "Committees are natural pigeonholes".

One of the main reasons for such deadlocks is lack of preparation. Such failure to analyze and outline the problems beforehand appears in several forms. Committees frequently offer symptoms in place of solutions, or long lists of unevaluated ideas in lieu of a single precise recommendation which strikes at the crux of the problem. Usually you can avoid these disappointments by taking the time beforehand to prepare an agenda and a clear statement of the problem which you want discussed. In doing this, it is important to clarify your own thinking. You must separate symptons from statements of the problem at hand. If you call the members together to gain the value of their experience, put the question in terms which genuinely invite their recommendations. In any case, you will gain results from a meeting in proportion to the amount of time you put into preparing the agenda.

8. Set a Time Limit

If you don't do so already, this may be a good time to start. One of the greatest complaints against a committee system is that it wastes your people's time, taking them away from urgent duties which demand their attention. You can ward off this type of criticism if you set a definite time limit to your meetings. This will permit members to set up appointments and allow secretaries to hold phone calls. The most important advantage, however, is the effect it will have on you, the chairman. You will appreciate the lack of time and press ahead to make full use of the time allowed.

9. Make One Man Responsible for Follow-up

Because in committees responsibility is diffused over a number of members, there is a tendency for committee resolutions to lie dormant, with no one taking over the responsibility for carrying them through to completion. Even if the committee decides on a sound recommendation it usually hands the responsibility for carrying out these decisions right back to the person who proved unable to handle them in the first place. In one company, this caused a product to be so delayed that it came out months behind competition. You can avoid such disasters by assigning the responsibility for carrying out recommendations to a single individual.

Rewards of Preparation

This brings us back to the opening theme. The main uses of the committee are either to exchange information or to attain agreement toward some course of action. If the members keep these two goals in mind, and adequately prepare for the meeting, they'll have little trouble holding swift and useful sessions. END

Recruiting Engineers Abroad

How good are the prospects for recruiting technical personnel abroad? American companies have been asking this question with increasing frequency as the supply of homegrown talent appears inadequate to meet America's growing needs.

Dr. H. H. Woerdermann, President of the Magnetic Research Corporation of Los Angeles, recently completed a two-month recruiting trip in Germany, and has this to say: Don't pin your hopes on foreign engineers; they're not likely to accept your bid. Most West German engineers are happy at home; they're satisfied with living conditions; salaries are high; working conditions are good; and engineering prestige is excellent. In fact, the European's conviction that scientific prestige is low in America crops up quite often in conversation, Dr. Woerdermann reports. He was frequently forced to dispel the notion that science in America is low-rated and government-controlled. By and large, the average European engineer feels that he can satisfy every personal and professional ambition in his own country.

Legal Barriers

Recently, the West German government raised a new obstacle to technical recruiting abroad by denying newspaper space to American technical recruiting ads. Another regulation forbids engineers to quit their jobs except at quarterly periods. How can American firms overcome these obstacles? Dr. Woerdermann attributes his success in landing 10 top-flight engineers to the fact that he operated prior to the ban on advertising. However, to Americans who want to try their hand at wooing foreign talent in spite of these restrictions, Dr. Woerdermann offers the following advice:

1) Send as your representative someone with a background in the country's language and culture. Dr. Woerdermann, who was educated in Germany, believes that his ability to speak German and his knowledge of the country greatly helped his talent hunt.

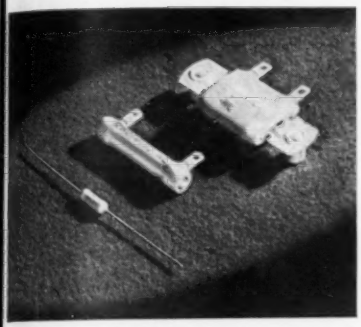
2) Stress the similarities between the American and European ways of life and approaches to science, not the differences.

The Matter of Adaptability

How long can you expect a European engineer to remain in the United States? Will he become homesick immediately and return to Europe? Dr. Woerdermann answers that it's not a matter of homesickness. Many engineers deliberately intend to return to Germany after picking up a few years of experience here. However, he is convinced that the American standard of living will quickly make them change their minds. Those who originally fled from Eastern Germany have no doubts whatever about staying in America.

Dr. Woerdermann does not believe that the breaking-in period will be too troublesome. Most European engineers have already studied English for several years as part of their engineering curriculum, and most of them write their letters of application in English.

COMPONENTS



MilSpec Power Resistors

A new line of power resistors conforming to MIL-R-26C for Fixed Wire-Wound Power-Type Resistors is the first to be offered in all sizes. Of vitreous enamel contsruction, the resistors are suited for applications where exceptional stability and reliability are needed. They are made with characteristics G, V or Y, in three basic mounting types—stack mounting, tab terminal and axial lead. Maximum dissipation ratings range from 2.5 to 210 watts. Ward Leonard Electric Co., Mount Vernon, N.Y.

CIRCLE 40 ON PAGE 48 FOR MORE INFORMATION

Gear Boxes

Precision, miniaturized gear boxes for electronic and instrument applications are available. In three series, Sizes 11, 15 and 18, the small, compact gear boxes have a wide range of gear ratios, from 4:1 to 12,000:1. Size 11 gear box provides torque up to 45 oz-in. Sizes 15 and 18 provide torque up to 65 and 100 oz-in, respectively. Precision ball bearings are used throughout. The gear boxes can be mounted directly to small electric motors. Southwestern Industries, Inc., 5880 Centinola Ave., Los Angeles, Cal.

CIRCLE 41 ON PAGE 48 FOR MORE INFORMATION

Card-Type Resistor

This encapsulated, wafer-thin, card-type resistor is specifically designed for applications where limited space prohibits the use of the usual cylindrical, bobbin type resistors. It is especially adaptable for circuits using transistors, in guided missiles and airborne communication and navigation equipment. These units will meet the environmental requirements of MIL-R-93A, Amendment 3. The Daven Co., 530 W. Mt. Pleasant Ave., Livingston, N.J.

CIRCLE 42 ON PAGE 48 FOR MORE INFORMATION

Reliable Relay

A high-reliability d-c relay has been developed for use in guided missiles and similar critical applications. It is a rotary-type, two-pole, double-throw unit, designed to withstand extremes of temperature, humidity and shock. It can be used at altitudes up to 80,000 feet. Design features of the 206W1 relay include palladium contacts, precision-balanced rotary motor, and a one-piece extruded can with silver-soldered mounting flange to insure high resistance to vibration and shock. The relay also contains an active "getter" to absorb residual gas and organic vapors. Radio Corp. of America, 30 Rockefeller Pl., N.Y.C. 20.

CIRCLE 43 ON PAGE 48 FOR MORE INFORMATION

to 6000psi

A multi-purpose two-way solenoid valve for up to 6000psi service, weighing only 0.70 lbs. with a flow area of approximately 0.125, this valve is recommended for long term 3000psi applications also. Simply changing the seal material makes the valve usable with practically any line fluids in use today. The solenoid is activated by the conventional 28v d-c current or can be made available with an additional configuration for an operational current of 124v, 400 cy a-c. Added features are simple mounting, rugged design, full line back pressure with negligible back leakage. The solenoid is rated for continuous duty at 25w and is completely sealed. Marotta Valve Corp., P.O. Box 330-52, Boonton, N.J.

CIRCLE 44 ON PAGE 48 FOR MORE INFORMATION

Cable Tap Connector

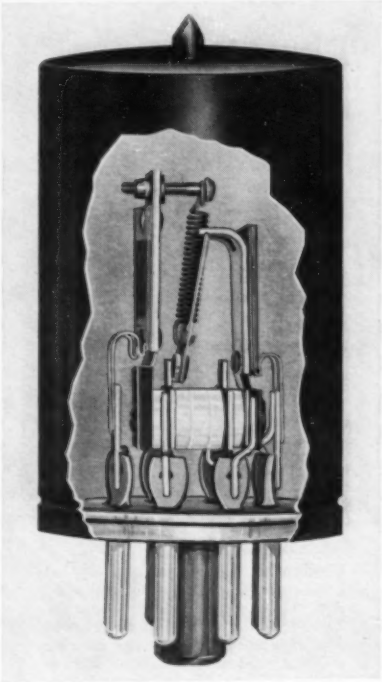
A fully insulated one-piece tap connector for shielded or coaxial cable is quicker to install than any previous method of connecting or grounding. Combining a one-piece inner and outer ring, and nylon insulation, the inner ring slides under the shielded braid as the tap wire is held between the braid and the outer ring. The Uniring is constructed so that the inner ring is unaffected by the crimping process, insuring maximum protection to the cable. Single or multiple taps, can be accommodated from either front or back of the connector. The nylon insulation is color coded and extends beyond both ends of the ring, eliminating metal to metal contact, or chafing in tight locations. Burndy Corp., Norwalk, Conn.

CIRCLE 45 ON PAGE 48 FOR MORE INFORMATION

Thimble-Sized Detector

A rugged, highly sensitive sub-miniature photo electric detector is self generating, permitting simplification of circuitry. The Model 6350 unit furnishes output proportional to input light intensity and loading. Typical input-output proportions are 300 Millivolts at 100 foot candles into 1 Megohm, or 20 Microamperes at 100 foot candles into 100 ohms. Autron Engineering, Inc., 1254 W. 12th St., Los Angeles 17, Calif.

CIRCLE 46 ON PAGE 48 FOR MORE INFORMATION



Thermal Memory Relay

This device is a bistable time delay relay with single pole, double throw snap action contacts. It is thermally operated, with two separate heater circuits. Each of these transfers a movable arm from one contact to the other. The relay being bistable remains in either of the two contact positions until operated by the appropriate heater circuit. Because of the thermal actuating characteristics, a time delay occurs with each operation. The bimetal strips are perfectly matched, thereby cancelling the effect of ambient temperature upon relative deflection. Thermal Devices Sales Dept., Curtiss-Wright Corp., Electronics Div., Carlstadt, N. J.

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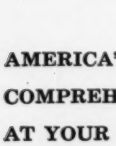

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CIRCLE 48 ON PAGE 48 FOR MORE INFORMATION

r/d contracts

Boiling Water Reactor

A 600,000kw atomic power plant to cost betwen $20-$25 million has been commissioned by a group of 10 midwest power companies. An advanced type of nuclear power reactor—a controlled recirculation boiling reactor—designed by Allis-Chalmers, Milwaukee, Wis., will be used. One of the principal features of this type reactor is its high energy output per unit of volume, because of the great amount of water being continuously recirculated. The slightly radioactive steam flowing through the turbine will be sealed in by special seals on the turbine shaft.

Boiling water reactors similar to the CRBR have been proven by the AEC to possess an unusually high degree of inherent safety. The presence of water within the reactor core is essential to keep the nuclear chain reaction going. Any excess heat generated by the fission process causes an increase in the amount of steam within the reactor, displacing the water and causing the action to slow down.

Flight Trainer

The first universal digital operational flight trainer—designated "Udoft"—is being developed by Sylvania Electric Products, Inc., for the U.S. Naval training Device Center, Port Washington, N.Y. A new, very quick-thinking type of electronic brain will be used to simulate a wide variety of aircraft, including supersonic jet fighters. The project is sponsored jointly by the U.S. Air Force and the Department of the Navy.

Test Sets

A $202,157 contract to supply low-voltage, heavy-duty test sets for Rossford Ordnance Depot has been awarded to Atomic Engineering Corp., Grand Junction, Col.

Rocket Models

ARDC has negotiated a half-million dollar study contract with Minneapolis Honeywell for design, mock-ups and wind-tunnel models of a proposed air-to-ground rocket.

Lead in Ceramics

A fellowship for research on lead in ceramics will be sponsored at University of Illinois by the Lead Industries Assn. This is in addition to a similar grant to Rutgers, which we reported last month.

Data Recording System

A data recording and digital data reduction system will be designed and built for the Navy's new test facility at the David Taylor Model Basin, Carderock, Md., by Consolidated Avionics Corp. The instrumentation will program the measuring, recording and testing instruments for compiling all data from experimental runs. Separate systems will be installed for measuring and recording in each of the two test basins.

Reactor Control Console

A console designed for safe reactor operation will be used on the Far East's first atomic energy reactor now under construction near Tokyo. The console, built by Reed-Curtis Nuclear Div., American Electronics, Inc., includes control instruments, recorders, alarm systems and power supplies.

Missile Instrumentation

A guided missile instrumentation contract in the amount of $19,500,000 has been let by the Denver Division of Glenn L. Martin Co., to Associated Missile Products Corp., Pomona, Calif. This firm is a subsidiary of American Machine & Foundry Co., and a member of its Defense Products Group.

Scatter System

U.S. Air Force Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio has retained General Electric Co.'s Technical Products Department to develop, mock-up and test a new single sideband tropospheric scatter system. This will be the first prototype of what is expected to be a stepping stone to transoceanic telecasting.

Measurements

The Army Signal Supply Agency has awarded a $560,000 contract to University of Michigan for continued research in the field of electronic measurements.

Two Instrument Contracts

Two contracts totalling over $4 million have been awarded to General Precision Laboratory Inc., Pleasantville, N.Y., by the Air Materiel Command, Wright-Patterson AFB, Dayton, Ohio. One is for research and development in advanced airborne navigation systems; the other for manufacture of electronic control amplifiers for navigators.

The Ubiquitous SEAL

(continued from page 16)

insert at the same time. In the home blender, an ingenious metal-to-metal seal that does not deteriorate in the presence of foods or leak after long use also acts as a bearing. In some thermostat switches a sealed container is also the thermostat element. Reduced time lag is one advantage of this arrangement. Electronic components and assemblies are frequently potted to gain mechanical rigidity, but gain the additional benefit of sealing against moisture and corrosive atmosphere as well.

One small electronic manufacturer gains a double advantage with encapsulated sealing. They developed a new type of semiconductor device. Instead of seeking the questionable protection of the patent laws, they pot the unit in a compound that is practically indissoluble. Any solvent that could conceivably dissolve the potting compound would also destroy the delicate semiconductor or the fine wires connected to it. Several types of feed-through capacitors also offer sealing as a by-product feature.

Seals that seal against two markedly different substances might also be called double-duty seals. One such gasket consists of rubber moulded over wire mesh. The rubber keeps water out of an electronic device, while the wire mesh prevents radio frequency waves from leaving. Compressing the gasket in place forces the ends of the mesh to cut through the rubber and make electrical contact with the metal flange areas.

Measuring the Seal

The techniques and equipment for measuring the performance of a seal are becoming more and more sophisticated. A great variety of devices ranging in cost from a few dollars or a hundred dollars to $15,000 (for a mass spectrometer) are on the market. Obviously, in the field you only need a meter that is as precise as the spec for which the seal is being prepared. In the R/D lab, however, where the causes of the failure more than the mere fact of failure must be found, the most precise instruments are in order.

In testing for what may seem special sealing conditions, such as high altitude or low tempraturs, some of the most expensive test gear is demanded. Testing for humidity or rain-tightness is also a chore (some military specs are so finely written that they specify the angle at which a jet of water is to be directed at the object under test.) These special environmental tests become very stringent when effects like humidity, sunlight, and dust are combined.

R/D in Sealing

Who performs the research and development in sealing—the manufacturer of the sealing material or the one who wants to make the seal? Usually the latter, but in some cases the material manufacturer. Several outstanding examples of the former are the Corning Glass Works, Minnesota Mining, and DuPont.

For those interested in new sealing materials and techniques, keep an eye of course on the National Bureau of Standards in Washington. Ranging over the problems of every American industry and the military as well, the NBS frequently makes contributions to the cause of good sealing. For example, it is engaged in the fundamental study of the high polymers—rubber, leather, etc. This work could easily lead to improved gasketing materials.

Sealing Is a Management Problem Too

In terms of design time and materials involved, your sealing problem may seem like a minor one in most situations. But the seal can have an enormous effect on the performance of a product or process. Your engineers and researchers must not relegate the sealing problem to the second order of magnitude. Not only must they be made aware of the latest advances in sealing materials, but they should be on the lookout for ingenious sealing solutions in other technologies or for equipment completely unlike that developed by your R/D group. Don't hesitate to authorize field trips to observe your company's products in action; the causes of sealing failure or new insight into the environment in which a seal must live may result.

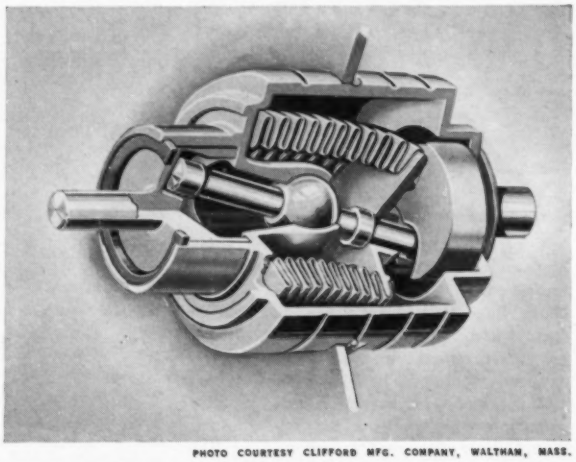


PHOTO COURTESY CLIFFORD MFG. COMPANY, WALTHAM, MASS.

PROBLEM: Kearfoot engineers needed an excellent seal around a rotating shaft leading into an enclosure under high vacuum.
INGENIOUS SOLUTION: Solved by means of a bellows. The rotation is converted into nutating action by the rocker arm as shown above. The other end of the arm turns a shaft leading into the chamber. Although tightly and rigidly sealed to the nutating arm, the bellows can follow its motion.

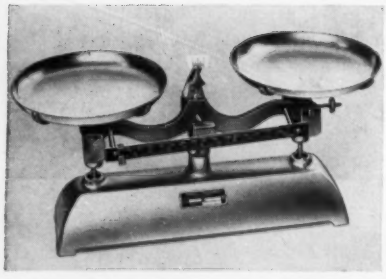
Make sure that the specifications for seals are very carefully drawn and that vague terms like water-proof or hermetic are fully defined. Make your staff anticipate what higher performance for an equipment will demand of its present seals. Don't leave the sealing problem to the end. What could be more embarrassing for an R/D organization than failure to deliver an expensive prototype for lack of a good two-dollar seal?

For the R/D group that faces many sealing problems during the year, there may be a temptation to designate one engineer as the sealing specialist. In general this would be a dangerous if seemingly more efficient arrangement. It would tend to relieve your other professionals of the responsibility for studying the sealing situation with the concentration it deserves and is receiving throughout American industry.

Sealing is a milleniums-old art that has held its place in our expanding technology. Urged to new extremes of performance and environment, sealing like the rest of technology is evolving from art into science.

Arthur L. Kaufman is a project leader with Barnes Engineering Co., Stamford, Conn. Educated at R.P.I. and Cornell's School of Engineering, he was formerly with the Frankfort Arsenal.

LABORATORY EQUIPMENT



Lab Scales

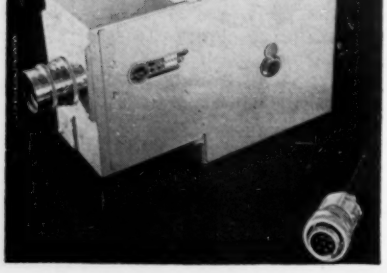
Very high sensitivity (25 mg) combines with high capacity (2 kg) in an improved laboratory balance. The weigh beam has been lengthened to provide fast, sensitive readings without weights, on measurements up to 10 grams. All exposed parts are heavily plated to resist corrosion. A set of metric or troy precision weights in a hinged-lid block is optional. Henry Troemner, Inc., 911 Arch St., Philadelphia 7, Pa.

CIRCLE 50 ON PAGE 48 FOR MORE INFORMATION

Power Supply

Two output voltages, 1 to 100 vdc each, are provided in a new power supply for precision lab. measurements. Both are linear throughout the entire range—an exclusive feature. Output voltage is set with a 10-turn multipot, on which each turn is equivalent to 10v of the outer scale; the inner dial being scaled accurately for easy setting of 0.1v increments. Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena, Calif.

CIRCLE 51 ON PAGE 48 FOR MORE INFORMATION



Constant-Temp Ovens

Designed for applications requiring precision controlled temperatures from 60° to 250°C., an improved line of constant temperature ovens incorporates a number of new features. Among these are: stainless steel interiors; more accessible front-mounted controls; improved chamber design; sealed nickel-chrome heating elements, non-arcing thermostat; insulation which provides high heat retention. Four sizes are available. Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill.

CIRCLE 52 ON PAGE 48 FOR MORE INFORMATION

Sensitive Scope

Extremely sensitive, the Type 403, oscilloscope features a full scale amplitude measuring range from 1 millivolt to 500v. The instrument can resolve a 20 micro-volt signal and allows direct reading of millivolt outputs of gages, pressure pickups, accelerameters, etc., without pre-amplification. Allen B. Du Mont Labs., Inc., 750 Bloomfield Ave., Clifton, N.J.

CIRCLE 53 ON PAGE 48 FOR MORE INFORMATION

Certified Reagent

Sodium Tetraphenylboron, increasingly popular as a reagent for potassium determinations, is available as a certified reagent with a minimum assay of 99.5% and individual lot analyses. It has been proven superior to the chloroplatinate method in accuracy, speed and economy. Other uses of Sodium Tetraphenylboron include: the detection of analgesics, alkaloids and nitro compounds. Fisher Scientific, 315 Fisher Bldg., Pittsburgh 19, Pa.

CIRCLE 54 ON PAGE 48 FOR MORE INFORMATION

Fast Photo Recorder

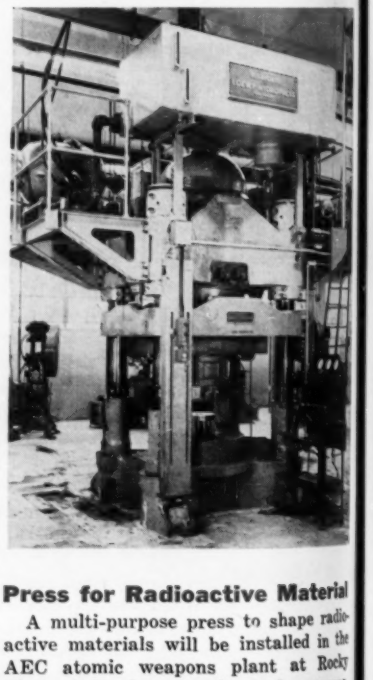
This 16mm high speed photographic data recorder will take up to 200 frames per second. Capacity is 200 feet and power requirement is 28v d-c. Developed especially for aircraft and missile use, Model VDR- 52 has passed environmental tests. A smaller model of 100 foot capacity is also available. Vought Co., P.O. Box 1350, Beverly Hills, Calif.

CIRCLE 55 ON PAGE 48 FOR MORE INFORMATION

Nitrogen Cryostats

Nitrogen cryostats, which can cool infrared detectors to approximately —196°C, are available for laboratory applications. The new cryostats are completely enclosed recirculating systems with no danger of spilling or loss by evaporation. The cooling heads can be operated at any desired angle. The Model 147 cryostat consists of two basic components—a miniature cooling head and a compressor-regulator assembly. The cooling head uses the Joule-Thomson effect and the principle of regenerative cooling. It is designed to operate from a nominal 117V a-c power supply and is available with a variety of cooling heads. Perkin-Elmer Corp., Norwalk, Conn.

CIRCLE 56 ON PAGE 48 FOR MORE INFORMATION



Press for Radioactive Material

A multi-purpose press to shape radioactive materials will be installed in the AEC atomic weapons plant at Rocky Flats, Colo. for experimental purposes. Developed by the Loewy-Hydropress Div., Baldwin-Lima-Hamilton Corp., Philadelphia, Pa., the press combines the Guerin rubber-pad process with conventional steel die-forming. The male die is of steel, but a rubber pad replaces the female die. The press will operate in an airtight structure of stainless steel and lucite. Long rubber gloves will be built into the shield for manual operations within the chamber.

ENGINEERS...

Let's exchange resumes

NAME:
Douglas Aircraft Company, Inc.

POSITION:
World's largest manufacturer of aircraft and missile systems.

LOCATIONS:
Santa Monica, El Segundo and Long Beach, California; Tulsa, Oklahoma; Charlotte, North Carolina.

AGE:
37 years in aircraft; 15 in missiles.

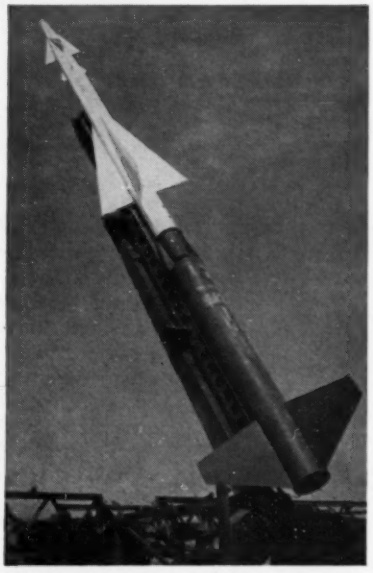
EDUCATION:
An engineering company managed by engineers—such as Donald W. Douglas, B.S., Aeronautical Engineering (M.I.T.); F.W. Conant, B.S., Civil Engineering (Cornell); and A. E. Raymond, B.S., Mechanical Engineering (Harvard), M.S., Aeronautical Engineering (M.I.T.), and Ph.D. (Hon.) (Polytechnic Institute of Brooklyn)—and with key staff positions held by graduate engineers, physicists and mathematicians, many with advanced degrees.

EXPERIENCE:
Holder of many "firsts," such as
—first airplane to carry a pay load equivalent to its own weight. (1920)
—first globe-circling airplane. (1924)

Builder of the famous "DC" series of commercial aircraft.
—every six seconds of each day, a Douglas commercial airplane takes off or lands somewhere in the world.
—currently producing the ocean-spanning DC-7C.
—soon to be in service, the exciting jet-powered DC-8.

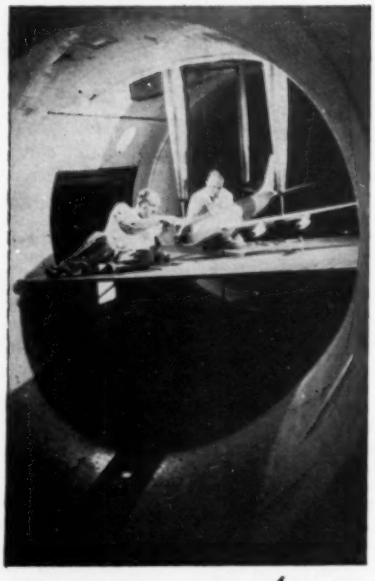
Builders of nearly one-sixth of the planes produced in America during World War II.
Currently building even finer transports, jet fighters and bombers.
Pioneer in missile research and production with nine separate projects.

REFERENCES:
Every major airline in the world.
Thousands of manufacturers of components for aircraft and missiles.
The U.S. Army, Navy and Air Force.
Some 80,000 Douglas employees throughout the country.



NIKE I, a radar-guided missile, intercepts bombers at supersonic speeds despite evasive action.

Engineers modify DC-8 configuration in wind tunnel tests for stability and control data.



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C. C. LaVENE
DOUGLAS AIRCRAFT COMPANY
BOX P-620
SANTA MONICA, CALIFORNIA

GO FURTHER WITH DOUGLAS FIRST IN AVIATION

TECHNICAL MANAGEMENT *(Cont. from p. 6)*

The next step upward entails greater demands on his time and many more factors to be weighed and balanced. The need for coordination with many of the other functions is made obvious. At this point he senses real trouble with the rank-and-file engineer, since he is now two steps removed. Unless his memory is good, it is difficult for him to appreciate the role in which they see him; i. e. as chief blocker of real technical progress. They may like to talk with him, but if, in the face of overwhelming technical evidence, he decides to abandon the work or direct it differently, he has a real job on his hands to explain his actions to them. It is hard to explain that the many elements which lead to decisions must, of necessity, be affected also by non-technical considerations.

Here is the dilemma as I see it. The engineer on the working level wants to feel that his supervision is at least as smart or smarter than he is. Because he hasn't the perspective he is very apt to conclude that his supervision is stupid. Because of his limited point of view he is unable to recognize sound non-technical considerations which are very influential at the higher level. The man at the top must make many decisions and he doesn't like to have his intelligence questioned by persons who are not in a position to know all the factors. Nor can he always take the time to explain and justify all decisions. Besides, he gets directives from top management which may make little sense to him also. What is the answer to good understanding? I'll let you readers supply the answer. I have a few ideas but I am sure that there are many of you who have thought about this a great deal. I would like to know what techniques are available to promote greater understanding so that our organizations can function with the maximum effectiveness. Please write in your recommendations for orienting an organization to accomplish the jobs set forth. *(Address your letters to Dr. Merritt Williamson,* RESEARCH & ENGINEERING, *77 South St., Stamford, Conn.*

Discussion of November's Problem

I am going to repeat the problem of ethics first mentioned in the November issue and give you the analysis contributed by Professor Meyer of Pennsylvania State University. If anyone wants to contribute further the column is still open.

John Hull is a clever and imaginative engineer but is young and needs several more years of guidance under a mature leader before he can attain his maximum effectiveness. He is, of course, ambitious, and feels that he is being "kept down". Attempts have proven unsuccessful in getting across to him that he lacks certain experience to make him a good supervisor. He is paid more than any of his contemporaries.

In the city where he works a former employee of his company, Mr. Ingle, has established a contract engineering agency. He has offered to double John's salary and he has a ready place to rent him out for 5000 more dollars than he must pay him. John is interested. He is young, although married and a father. He likes the idea of more money, greater diversity of work and feels that he should accept Ingle's offer.

If you were John Hull's boss and he came in to talk to you about making a change, what would you advise him? If he decided to leave you, would you recommend him for rehire if he should want to come back? Do you think he is behaving in an ethical professional manner? Would you be ethical if you recommended against his rehire? Is Mr. Ingle ethical in the whole transaction? If the company which will employ Hull through the agent acting ethically? This situation seems to offer an opening for particularly lively and enlightening discussion

Professor Meyer writes, "Such men as John Hull are fairly common and as they come to the fore the greater the need for men in advanced positions is. Consequently John Hull's boss would do well to fill the position to which John is aspiring. Of course he must do this with a man who clearly excels in those areas in which John is not yet proficient.

"However, admitting the possibility that this solution is inadmissible, the only practical remedy is to let John go wherever he chooses. Unless he undergoes a profound change in his thinking while away from the company, I believe it is perfectly ethical to recommend against his rehire at any time. John will try to push himself upward no matter what his position is. This is not only a nuisance, but it also has a disturbing influence on the morale of the organization.

"Is Mr. Ingle ethical on the whole transaction? This question can of course arise only if he is fully aware of the reasons for John's willingness to leave his former employer and that he is basically in accord with John's superior regarding John's qualifications. If this is so, Mr. Ingle must certainly be accused of unethical conduct since, in order to sell John's services at $5000 profit, he must be offering them for a position about that which John now occupies. Because he knows John isn't ready for such a position, he is putting something over on his client.

"John himself is a more difficult case. The question is does he really believe that he is ready for something better than his present position. If he does, he can be accused of nothing worse than youthful overestimation of his own abilities, something which time will undoubtedly correct. If he does not, he is a bluffer and a fraud and his superior will do well to get rid of him since no technical department can be managed properly with such people."

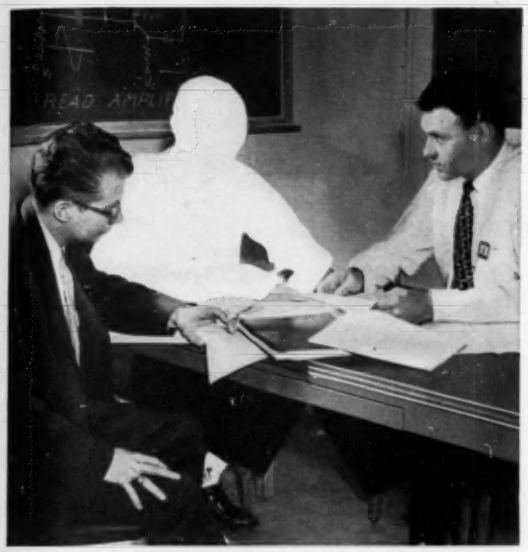
On Promoting Technicians to Scientists

In the last issue, you may recall, I asked my readers to write if they knew of any method by which technicians can be promoted to scientists. Alfred M. Pommer of Kensington, Maryland writes that there is no way to do this at the present time. "However," he adds, "as an expedient it is possible to have technicians submit to the appropriate Civil Service examination. The U.S. Civil Service Commission is accepting applications on an open-continuous basis at this time.

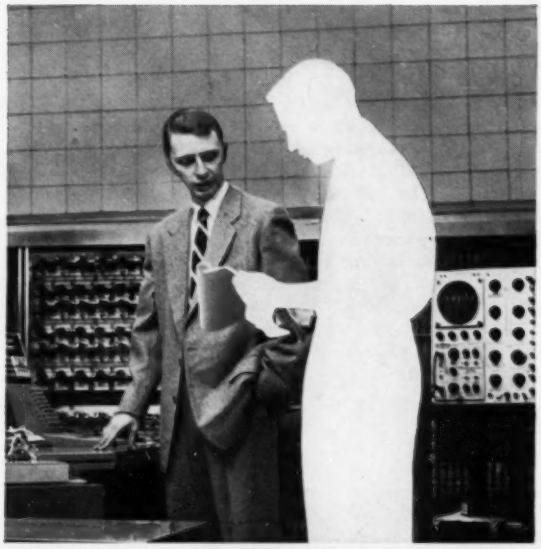
"If a candidate receives an eligible rating on the examination, it may be used as a basis for promotion.

"It may be preferable to retain the chairman of the science department of a university as a consultant to certify whether the candidate has the equivalent of a college education. The consultant may rely on written and oral examinations, reports from supervisors, and academic transcripts. He probably should not be identified with management." END

IBM GROWTH promoted these men



PRODUCT DEVELOPMENT ENGINEER: Before his recent promotion, this man was a member of a small engineering "team" (two M.E.'s, an E.E. and a model maker) in IBM's Poughkeepsie plant. His specific project entailed the creation of the "ultimate package in printed circuitry." His group "brainstormed" the project in continual sessions, putting the results in model form. Then the group would try to "tear the idea to shreds" in order to create something even better.



PRODUCT CONTROL ENGINEER: Promoted recently, this man formerly worked at IBM's Poughkeepsie manufacturing facilities. His job was to design information systems to insure a smooth flow of work through the plant. "It takes *creative* engineering ability to design these systems," he'll tell you, "and *administrative* ability to 'sell' a system to higher management and make it stick. If you possess this rare combination of abilities, this is the job for you!"

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Economic experts rank the electronic computer with automation and nucleonics in growth potential. More than 10,000 electronic computers will be in operation by 1966. IBM sales have doubled, on the average, every five years since 1930. IBM engineering laboratory personnel quintupled in the past five years. IBM spent $19,000,000 on research and new product development in 1956. Salaries are excellent; company-paid benefits set standards for industry today. Personnel turnover at IBM is less than one-sixth the national average.

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Pyromillivoltmeter

Weighing only 14 ounces, an accurate precalibrated thermocouple pyrometer features a large, easy-to-read dial, dual-calibrated from 0° to 750°F and from 0° to 400°C. The indicating pyromillivoltmeter is supplied with a five-foot iron-constantin thermocouple, with a thin sensing disc having external resistance of 10 ohms. It is mounted on an angled faceplate for portable use, but may be removed for panel mounting. Arthur F. Smith Co., 311 Alexander St., Rochester 4, N.Y.

CIRCLE 18 ON PAGE 48 FOR MORE INFORMATION

Point Probe Microanalysis

This new metallurgical research technique permits analysis of steel-specimen areas 10,000 times smaller than is possible by any other method. An electron microscope, modified for analysis by X-ray emission spectroscopy is shown being focused by a scientist at U.S. Steel's Research Center in Monroeville, Pa. Area of specimen to be studied is adjusted under the electron beam by means of a mechanical stage manipulator and an optical binocular microscope.

CIRCLE 19 ON PAGE 48 FOR MORE INFORMATION

Vacuum-Tube Voltmeter

An improved model vacuum-tube voltmeter has been introduced, which has accuracy of better than ±2% on all a-c and d-c voltage ranges. Its completely shielded diode probe is designed for use into the u-h-f range. Other features include a high input impedence, d-c polarity switch, illuminated meter scale with mirror and knife-edge pointer, and insulated input terminals allowing the panel to be grounded at all times. Greater stability has been achieved by advanced circuit design, power-supply regulation and the use of long-term stable precision components. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

CIRCLE 20 ON PAGE 48 FOR MORE INFORMATION

Pressure Transmitter

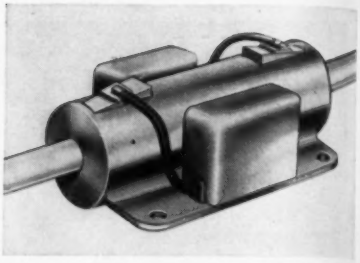
This inexpensive indicating pressure transmitter accurate to ±1/2% of scale range, for pneumatic transmission of process pressure measurements measures pressures of 0—30" of water to 0—6000psi, transmitting a 3-15psi air signal to indicating, recording or control instruments. The transmitter has an eccentric indicating scale, visible at a distance of 20 feet, built into the front of the case, eliminating the need for a separate field gauge. A choice of standard pressure elements is offered; spirals, helicals, bellows and diaphragms. The Foxboro Co., Foxboro, Mass.

CIRCLE 21 ON PAGE 48 FOR MORE INFORMATION

Performance Test Set

With the increased necessity for preflight testing of airborne electronic equipment, a unit has been developed to analyze weakness and predict possible in flight failures. The instrument is designed to furnish all necessary performance measurements on transmitting and receiving equipment in the 190 kc —400 mc range. It consists of a transmitter performance monitor, two R.F. signal generators covering the frequency range of 190 kc to 400 mc, and a multirange of 20,000 ohm/volt ac meter. It has been approved by BuAer-Navy. Trad Electronic Corp., Asbury Park, N.J.

CIRCLE 22 ON PAGE 48 FOR MORE INFORMATION



Measures Flow-Rates

A straight-through flowmeter achieves accurate measurements by the modification of an ultrasonic beam. Since there are no obstructions to the fluid flow, pressure drop is eliminated, greater accuracy is attained, and maintenance is simplified. The device is especially recommended for measuring low-viscosity liquids. The Model UF-100 measures flow-rates in the range of 1000-4000 gpm, with accuracy of better than 1%, and provides 5-v full scale output to feed into standard telemetering and recording systems. Gulton Industries, Inc., 212 Durham Ave., Metuchen, N.J.

CIRCLE 23 ON PAGE 48 FOR MORE INFORMATION

Frequency Analyzer

This frequency analyzer determines the frequency amplitude spectrum of a random wave and the frequency and amplitude of individual components of a periodic complex wave within the frequency range of 2 to 25,000cps. The wave components are measured in decibels and in percent of total signal. Results are indicated on a calibrated attenuator and on a meter; outputs are also provided to drive a recorder. Technical Products Co., Instrument Div., 6670 Lexington Ave., Los Angeles 38, Calif.

CIRCLE 24 ON PAGE 48 FOR MORE INFORMATION

Multiple Indicator

A new drum-type precision indicator is made for quick readings of variables at remote points. The instrument uses the manufacturer's standard electronic components. It is equipped with numbered push button switches on the front of the case, and can scan up to 48 remote points quickly. The revolving scale has a calibrated length of over 26 inches, and full scale travel takes place in 4—1/2 seconds. The Bristol Co., Waterbury, Conn.

CIRCLE 25 ON PAGE 48 FOR MORE INFORMATION

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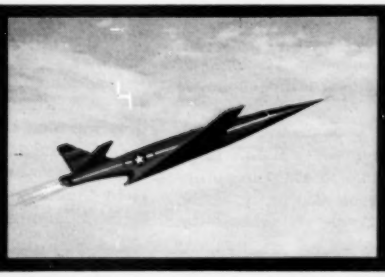

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GENERAL ELECTRIC

BOOKS

ON HUMAN COMMUNICATION

By Colin Cherry

Reviewed by Curtis Wilson, St. John's College, Annapolis, Md.

Sir Francis Bacon somewhere states that the more important truths of a subject matter are to be found at its periphery, where it impinges on all other subjects. In recent years there has been growing interest in the concept of communication as an intersection of a large number of subject matters, ranging from economics to phonetics, from diseases of the nervous system to telephony. Communication appears to be one subject whose periphery is everywhere and whose center is yet to be found.

The present book by Colin Cherry is intended as a general introduction to a series of texts on communication, to be prepared by different authors, and published during the next few years by the Technology Press of M.I.T. and John Wiley & Sons, Inc. The seven essays of the book, being re-worked lectures, are for the most part accessible to the general reader. They provide a survey of the concepts and problems which have played a major role in recent discussions of the theory of communication, its practical applications and philosophical implications. In addition, the book will be useful as a guide to the literature of communication theory and related fields; an extensive bibliography is included.

Professor Cherry is well aware that "at the time of writing, the various aspects of communication...by no means form a unified study; there is a certain common ground which shows promise of fertility, nothing more" (p.2). He is aware also of the source of the present widespread interest in, and search for, the bonds of unity between the diverse studies which employ the concept of communication. It stems primarily from mathematical developments in the fields of communication engineering and servomechanisms theory; in particular, the development of measures of "information", "redundancy", "channel capacity", etc.

But in this regard Cherry is a counsellor of caution. It is one of his principal theses that while the mathematical theory of communication has considerable relevance to domains outside telecommunication, its application to such domains should be made with the greatest care. The mathematical theory is "quite basic to the study of human communication—basic but insufficient"(p.9).

In particular, it should be noted that the concept of "information" as used in the mathematical theory is a purely *syntactical* concept. It applies only to a message understood as a selection from an alphabet of signs (say, the Morse code), and does not depend on the meaning (semantic aspect) or impact (pragmatic aspect) of the message as interpreted by the receiver. In the words of Shannon, one of the founders of the theory, 'the sematic aspects of communication are irrelevant to the engineering aspects". One should not conclude that the engineering aspects of communication are totally irrelevant to the semantic aspects; communication of "meaning" presupposes communication of "information" (in the technical sense). But "information" (in the technical sense) does not constitute a measure of "amount of meaning"; it is relative only to a given alphabet of signs used for coding messages.

A second limitation in the concept of information consists in the fact that the measure of information depends on prior knowledge of the relative frequencies with which the different signs of the alphabet will occur. Such knowledge requires that the source of messages be *statistically stationary*. In other words, any reasonably large sample must be representative of the sequence as a whole. In most cases of actual communication between human beings, the assumption of statistical stationariness cannot be made, so that the mathematical theory as it stands at the present day is inapplicable. For the same reason it is inapplicable to any learning source, or to social or economic systems of which the statistical structure changes with time.

Cherry does not regard such limitations as necessarily final. Thus he gives considerable attention to the possibility of a measure of semantic information based on Carnap's theory of probability.

But Cherry's aim is not so much to present solutions to problems as to outline a locus of unsolved problems, and to warn against some of the false solutions. He reviews developments in the fields of phonetics, statistical communication theory, logic, probability theory, the theory of signs as developed by Pierce and Morris, and the psychology of recognition. He tries to show how these fields impinge on one another, and why they need to be viewed from a common standpoint. And, as Cherry stresses, a common standpoint can be achieved only if the all-too-familiar categories of "mind", "matter", "vitalism", and "mechanism" are relinquished, or recognized for what they are—different ways of talking about very complex processes.

Despite its fairly detailed review of technical developments in various fields, *On Human Communication* is finally a rather fragmentary book, pointing to a unity which does not yet exist. But it will be an informative and helpful book to those—whether engineers or philosophers—who wish to be *au courant* of some of the most exciting developments in present-day science.

Published jointly by the Technology Press of Massachuettts Institute of Technology and John Wiley & Sons, Inc., New York, N.Y. 333 pages, $6.75

Two Books on Transistors

Reviewed by Robert Colman, Products Research Associates, N.Y.C.

HANDBOOK OF SEMICONDUCTOR ELECTRONICS

Edited by L.P. Hunter

The emphasis on fundamental principles and techniques in this handbook is laudable; it presents to the reader an overall and integrated picture. Mr. Hunter and his 12 co-authors present a survey of semiconductor electronics and a guide to the technological essentials and applications of the transistor, diode and photocell.

Industry's failure to standardize transistor symbols and equivalents has resulted in confusion. In this book, a listing and definition of symbols used precedes the introductory chapter on transistor characteristics. Part I deals with the physics of electrical conduction and rectification in the semiconductor. While this is not a treatise on solid state physics, Mr. Hunter deftly introduces new material in a way that gives the reader a firm understanding of the conditions influencing transistor characteristics.

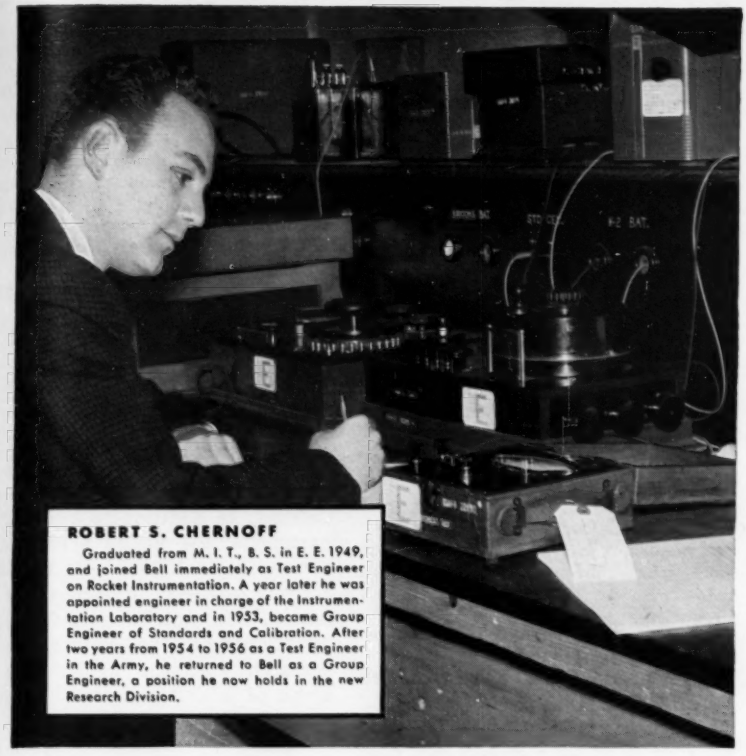
Junction characteristics are by far the most widely used, and so the writer uses junction transistor action to explain the mechanism of other types.

Enough information is given in Part II to enable an engineer in possession of suitable equipment to make a useable semi-conductor device. Sections dealing with junction preparation, crystal growing, and encapsulation are presented. Design and fabrication of representative semiconductors is explored as a means to further the engineer's understanding of limitations imposed on transistor characteristics by manufacturing technology. Transistor duals of high-frequency vacuum-tube circuitry require new thinking. To help the circuit designer, frequency parameters and equivalent circuit data are given.

Transistors are widely used in current computer developments: accordingly, switching circuits and their high speed application are treated extensively.

AC and DC choppers, direct coupled amplifiers and inverter circuits receive extended coverage. Design information on sinusoidal and relaxation oscillators

(Continued on page 46)



ROBERT S. CHERNOFF

Graduated from M. I. T., B. S. in E. E. 1949, and joined Bell immediately as Test Engineer on Rocket Instrumentation. A year later he was appointed engineer in charge of the Instrumentation Laboratory and in 1953, became Group Engineer of Standards and Calibration. After two years from 1954 to 1956 as a Test Engineer in the Army, he returned to Bell as a Group Engineer, a position he now holds in the new Research Division.

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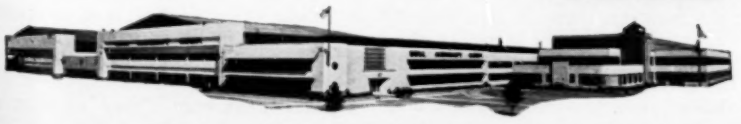

is given. With the treatment of the photo-transistor, however, the general excellent level of information has not been upheld. Lack of information, which this book might have supplied, has been a big factor in limiting use of this interesting device. The book concludes with an extensive bibliography of transistor literature which alone is worth the price.

The Handbook of Semiconductor Electronics has been written and edited with great care. It is coherent and easy to read. It offers a great deal of information and is particularly strong in low frequency amplifier design and switching circuitry. The researcher surveying the semiconductor field and the design engineer solving an application problem equally will find this book useful. Engineers in industry, government and graduate schools should find the availability of so much authoritative information within a single set of covers a valuable contribution.

McGraw Hill Book Co., New York, N.Y. 832 pages, $12.00

TRANSISTOR ENGINEERING REFERENCE HANDBOOK

By H.E. Marrows

New transistors and their applications are being developed so rapidly that it has not been possible to find a single volume that includes basic data on all the different types. The merit of this book is that it does supply this need, for commercially available transistors, cutting down on the necessity for searching through all the data sheets the various manufacturers make available.

As the manufacturers continue to make progress, new types of transistors appear and older models disappear daily. Any reference compendium suffers the limitation of being obsolete upon publication. This handbook is no exception. Currently two manufacturers represented in the book have stopped or curtailed production. Also absent are data on the newer transistor types, such as those of increased frequency range or greater power capacity.

The major portion of this book is a compilation of engineering data sheets covering transistors produced by 20 manufacturers, giving usual engineering data on 200 commercially available transistors. Included is a valuable digest of miniature components available for use with transistorized units. Commercial circuits and applications of transistors, providing a record of design thought in 1956, are included.

Transistors have not become as standardized as vacuum tubes and few types are made by more than one manufacturer. Replacement of transistors must be made by electrically equivalent types. Lack of a cross-index covering interchangeable types, and the rapid obsolescence of electronic components, gives this book limited appeal for the design or development engineer. The brief survey of the transistor and its circuitry is sufficiently non-technical to provide information to non-engineers interested in transistor circuitry and application. *John F. Rider, New York, N.Y. 288 pages, $9.95*

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IRONWORKS ON THE SAUGUS

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The Braintree and Hammersmith ironworks were constructed in the early 1640's in the Massachusetts Bay Colony. It was a forerunner of American big business and perhaps the most magnificent failure of the 17th century. The story of its conception and accomplishment, its progress and demise is here presented in a book that should absorb the historian of industry and divert those whose interest is in American history, in early technology, or in serendipity.

QUALITY CONTROL FOR PLASTIC ENGINEERS

Lawrence M. Debing, Editor

Reinhold Publishing Corp., 430 Park Park Ave, NYC 22.

139 pp + index, $4.95

The Society of Plastic Engineers was incorporated in 1942. One of its goals is the dissemination of technical information on plastics. It does this through its monthly journal and through a projected series of books, of which the present volume is the first. The book introduces the subject of statistical quality control to plastic engineers and other workers in plastic materials. Its work consists in its simplicity and clarity, and in that the reader need have no prior knowledge of the subject. Persons responsible for production of plastic products may here learn how to use basic statistical procedures in their field.

MANUFACTURING METHODS AND PROCESSES

By Arthur C. Ansley

The Chilton Co., Chestnut & 56 Sts, Phila, Pa.

552 pp + index, $12.50

Occasionally, a book appears that fulfills the promises made for it on its jacket. Or perhaps the jacket is less extravagant in its claims than usual. Whatever the case, the promises and the book are here in harmony. "It is designed to give the executive, the purchasing agent, or the design engineer, a broad, general background on the latest developments in manufacturing methods and processes . . . . it describes the method and equipment used in each of the processes and is illustrated with more than 450 pictures. The book places its principal emphasis on the type of parts made by each process, chief applications, and cost. Although it covers old standbys like sand casting, stamping, and machining, special attention is given to the new developments such as powder metallurgy, investment casting, plastics, ultrasonic machining, dielectric heating, and automation."

SCIENTIFIC RESEARCH IN BRITISH UNIVERSITIES 1955-6,

London, H.M. Stationary Office, 372 pp, indexed, $3.92 postpaid. (Also available from British Information Services, 45 Rockefeller Plaza, NYC 20.)

This volume provides notes on scientific research in progress in British Universities and University Colleges. In addition to heads of departments, the names are listed of permanent members of the staff actively engaged in supervising research. The entries give broad descriptions of the nature of the research sufficient to indicate the scope of activity of the department and of each research team.

WHAT HAPPENS IN BOOK PUBLISHING,

C. B. Grannis, Ed.

Columbia Univ. Press, 2960 Broadway, NYC 27. 399 pp + index, $5.50.

The whole complex process of publishing a book is here described by authorities in the various phases. Though not entirely germane to the concerns of the researcher or engineer, it is a source of information in the event that your department is planning a publication.—LS

International Dictionary of Physics and Electronics, W. C. Michels, Sr., D. Van Nostrand Co., 257 Fourth Ave., New York 10, N.Y., 1004 Pp., $20.

The terms defined in this book include laws, relationships, equations, basic principals, instruments, and apparatus. The fields covered include mechanics; heat and thermodynamics; low temperature physics; the properties of gases, liquids, and solids; acoustics; optics; electricity; electronics nuclear physics mathematical physics; representative topics in relativity. . . . Terms from areas bordering on physics are included: mathematics, chemistry, applied electronics and electricity, etc. The editors explain that their objective has been to provide a book useful as a general reference in physics, helpful even to the specialist in regions outside of his domain of specialized knowledge. They have succeeded handsomely.—LS

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Chopper 84
This unit converts d-c signals to a-c for telemetering and computers.
The Bristol Co., 169 Bristol Rd., Waterbury, Conn.

Lab Furniture 85
This line of furniture in stock sizes can be assembled to fit any size lab.
Fisher Scientific, 115 Fisher Bldg., Pittsburgh, Pa.

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This firm specializes in designing transformers to meet exacting conditions.
Peerless Electric Products Div., Altec Lansing Corp., 1515 S. Manchester Ave., Anaheim, Calif.

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Carl Zeiss Inc., 485 5th Ave., N.Y.C. 17.

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3	13	23	33	43	53	63	73	83	93
4	14	24	34	44	54	64	74	84	94
5	15	25	35	45	55	65	75	85	95
6	16	26	36	46	56	66	76	86	96
7	17	27	37	47	57	67	77	87	97
8	18	28	38	48	58	68	78	88	98
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